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Projection of California Agriculture to 1980 and 2000: Potential Impact of San Joaquin Valley West Side Development

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Giannini Foundation Research Report No. 312

September, 1970

ACKNOWLEDGMENTS

A large number of scientists, government officials, and leaders of the agricultural industry were contacted in the course of this study. Although it is impossible to mention each by name, the authors wish to acknowledge the considerable assistance they received from these individuals.

The authors wish to thank Dr. Kenneth Farrell, Dr. Loy Sammet, and Dr. J. Herbert Snyder for their helpful reviews of the material contained in this report. Gary Snider, Robert Tratz, Yuksel Isyar, and Robert Jensen gave valuable assistance in the collection of basic data. Appreciation is also expressed to the members of the Agricultural Economics Steno Pool for typing the manuscript. The authors, of course, accept full responsibility for any errors of fact or interpretation that may be contained in the report.

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PROJECTIONS OF CALIFORNIA AGRICULTURE TO 1980 AND 2000: POTENTIAL IMPACT OF SAN JOAQUIN VALLEY WEST SIDE DEVELOPMENT

by

Gerald W. Dean and Gordon A. King*

FOREWORD AND INTRODUCTION

Public investments are generally made with the twin goals of efficiency and equity in mind. Water resource economists have been leaders in the systematic application of benefit-cost analysis to assess the efficiency of public investment in water projects. Less attention has been given to equity, or the income redistribution, aspects of these projects. In a recent paper prepared as part of a three-volume report entitled "The Analysis and Evaluation of Public Expenditures: The PPB System" published by the Joint Economic Committee of Congress, Bonnen [1969, p. 434] comments on the irrigation aspects of water development as follows:

> "Since there exists a chronic overcapacity to produce in agriculture, the issue arises as to whether the development of new irrigation lands has any positive benefit nationally whatever its local value. In addition to which the creation of highly productive irrigated land in the West must (particularly in the face of the existence of excess agricultural capacity and acreage allotments) create, through production substitution, income losses in other regions. The question is where and what are the welfare implications."

Bonnen goes on to quote from a study by Howe and Easter [1969], to be published by Resources for the Future, Inc., in which the authors explore the interregional redistribution consequences of Bureau of Reclamation water development investment in the West (Bonnen [1969, pp. 435, 437]):

> "There can be little doubt from the data analyzed that reclamation irrigation has had a significant effect on U.S. agriculture. Increased production on reclamation-served land has increased USDA payments, stimulated regional production shifts, and reduced nonreclamation farmers' income . . . . These impacts of reclamation projects have not been adequately considered in evaluating project feasibility."

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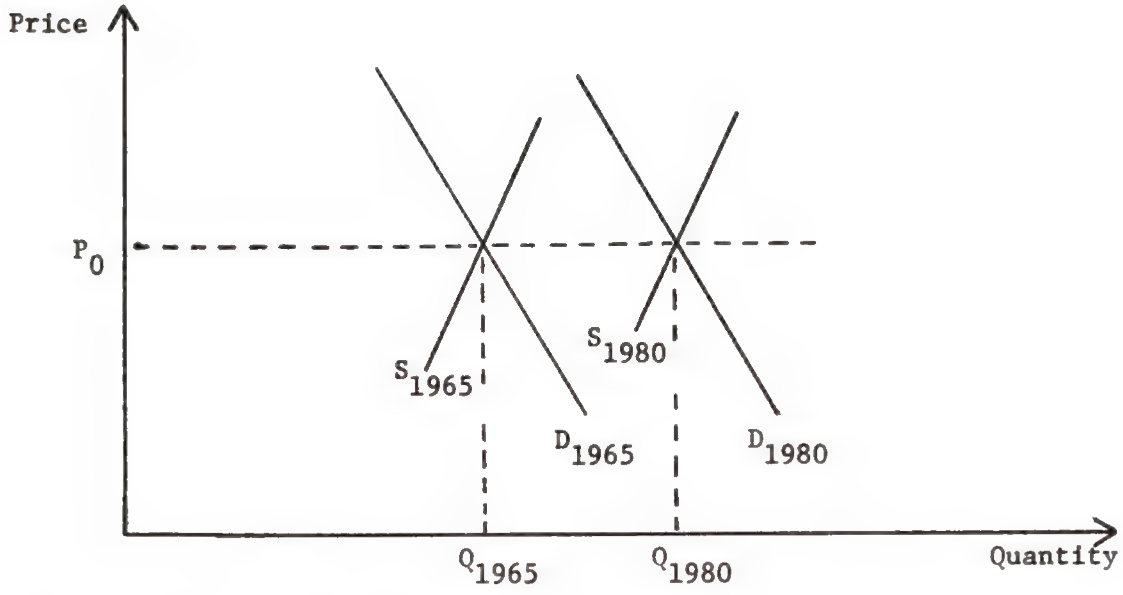
It is difficult to imagine a government investment project which does not redistribute income; in fact, this may be a prime reason for the project. In the water resources field, however, it is doubtful that income redistribution from one set of producers to another is intended as an explicit purpose of the project. Thus, implicit or explicit in most benefit-cost analyses of irrigation projects is the assumption of competitive price equilibrium at constant prices for the products of the project. Constant prices, of course, do not guarantee that there will be no income redistributions as a result of the project. Comparison of incomes, by group, "with" and "without" the project would show some redistribution, even at constant prices. But the constant price assumption minimizes the income redistribution effects among producer groups which would come about if, say, the newly irrigated acreage resulted in supplies which could be sold only at substantially lower prices. Lower prices would ordinarily lead to relative (and probably absolute) reductions in incomes for existing producers. The new producers would gain since economic feasibility of the project is based on increasing farmers' incomes in the new area. The redistribution is, of course, much more complex if the irrigation water to the new district is provided below cost as a public subsidy. A subsidy would involve income transfers from the consumers (taxpayers) as well as from other producers. Whether the consumer experiences a net gain or loss is, of course, not clear cut in such a case without further analysis.

The California Water Plan is a particularly complex undertaking from an economic point of view in that it involves multiple purposes including both municipal-industrial water supplies and irrigation water, as well as other purposes such as flood control and recreation. Also, both federal and State agencies are involved. The above discussion is only suggestive of the kinds of income redistributions which are implied in a series of projects of this magnitude and complexity. The present report will deal only with the irrigation aspects of water development in the State. It proceeds under the assumption outlined above--that an irrigation project is ordinarily planned so as to increase the quantities supplied of agricultural products over time at a rate which matches demand shifts, such that prices remain constant in real terms. The simple diagram below reflects such a situation, in which the supply and demand functions in 1965 (before the project) and 1980 (after the project) intersect at the same price P_0. Demand shifters include population, income, and tastes. The supply shifters are principally technology and new



acreage. Technology (reflected in increased yields per acre) is assumed to be exogenous. Therefore, new acreage is the major public decision variable which determines supply. Under the conditions outlined above, only enough acreage would be developed to allow the added supplies to be sold at constant prices.

Many irrigation projects are sufficiently small so that the assumption of no price effects is reasonable. The projected development on the west side of the San Joaquin Valley as part of the California Water Plan is, however, of sufficient magnitude so that the assumption of no price effects is dubious. This is true primarily because of the rather large acreages of tree fruits, nuts, grapes, and vegetables which are planned relative to the sizes of those markets in the United States.

This report explores the prospective price impacts on selected commodities of newly irrigated acreage being developed over the next two decades on the west side of California's San Joaquin Valley. The report is presented in two major parts. Part I provides a set of acreage projections for all crops in California which would be "required" to meet specified shares of the U.S. demand for these crops in the years 1980 and 2000. This set of projections is made within the framework outlined above; that is, the quantities and acreages "required" are based on expected demand shifts and constant prices through time. Part I also provides livestock projections, a feed-livestock balance sheet, and a broad comparison of "required" crop acreages with future irrigation acreages planned by the State and federal water agencies in California.

Part II of the report projects in more detail the probable supplies of selected commodities and commodity groups in the State, including the quantities of those commodities likely to be produced on the new west side acreage. These projected supplies are then compared with the quantities which would be "required" from the State to meet demand at constant prices. If the projected supplies exceed "requirements" at constant prices, estimated price elasticities of demand are employed to provide approximations to potential price effects. The importance of such supply and demand analyses in planning and staging water development projects is noted.

PART I

PROJECTIONS OF CALIFORNIA AGRICULTURE TO 1980 AND 2000

INTRODUCTION

The California economy has undergone far-reaching changes since World War II. California's favorable climate and physical environment have made the state a particularly attractive place in which to live. High technology, footloose industries--those relying on a highly trained labor force rather than being tied to particular geographic locations because of mineral deposits, power sources, or other natural factors--have grown rapidly in California, in part because of the availability of amenity resources (climate, mountains, coastline, etc.) attractive to their employees. External economies accruing to high technology firms which locate near renowned centers of higher learning also appear to have been a factor in the growth of footloose industries in California. In addition, California has become a favored retirement community. Based on these sources of growth, California's population increased from about 10.6 million in 1950 to about 20 million in 1969; projections are for a California population of 26.5 million in 1980 and 38.6 million by 2000 (California Department of Finance [1968]).

Along with rapid industrial growth and employment have come attendant pressures on California's agricultural economy. Urban pressure on land and water resource use are among the foremost problems facing California agriculture. Urbanization and industrialization in the Los Angeles and San Francisco Bay metropolitan centers, as well as in parts of the Central Valley and Southern Coastal Valley, have removed sizable acreages of high quality farmland from agricultural use. Land values and taxes in surrounding areas often have been forced to levels unjustified by strictly agricultural pursuits. A rapidly growing, affluent populace in California also has expanded the demand for recreational facilities and second-home sites in the foothill and mountain regions. Land values and real estate taxes in many of these areas have risen to the point where traditional agricultural uses such as cattle ranching and grazing are of questionable economic feasibility.

Decreases in crop land due to urban expansion have been offset by development of irrigated acreages in other areas. State and federal water development projects--with the dual purpose of servicing water-deficit urban areas and providing irrigation water for agriculture--will critically affect the future course of California agriculture.

Technological change in agriculture, new irrigation developments, and shifts in location of agricultural production within the State have thus far permitted California to retain its traditional share of United States markets for agricultural products despite the growing competition for land and water resources. Crop production has increased significantly in the past 15 years with no net increase in crop land employed. Livestock production has also grown substantially in the State, despite the competition for resources from within the State and from livestock production from other parts of the United States.

The questions posed in this study concern the possible future development of the agricultural sector of the California economy as it attempts to adjust to resource use pressures within the State and to changes in the demands for its products. The increases in demand are greatest for some of the products for which California has a unique climatic advantage such as certain fruits and vegetables. Will the land and water resources available to California agriculture in the future permit the State to continue to supply a constant or increasing share of the market for these products? What changes in the "mix" of cropping patterns and livestock production must be made to satisfy these shifts in demand? What implications do these changes have for the operation of individual farming units in the State?

Farmers, businessmen in industries related to agriculture, and government officials periodically make decisions based on assumptions, explicit or implicit, about future changes in California agriculture. Clearly these decisions should be based on the best possible information available. This report offers information which should prove useful as one input to the complex decisions which must be made at farm, business, and governmental levels.

OBJECTIVES

The specific objectives of Part I of this and a companion study by Dean, *et al.*, [1970] are to make the following projections of California agriculture to 1980 and 2000:

(1) Acreage, yield, and total production of the major crops;
(2) Numbers, feed utilization, and total production of the major types of livestock;
(3) Feed imports to balance feed production and utilization in the State;
(4) Land and water use by agriculture in the State, by region; and
(5) Changes likely to occur on individual farms.

FRAMEWORK FOR PROJECTIONS

All long-range economic forecasting techniques have severe limitations. The conventional quantitative tools of economic analysis (econometric models of commodity demand and supply, input-output analysis, linear programming) are better suited to short-run analysis than to long-range forecasting. Therefore, most long-range studies employ a combination of techniques, including both quantitative and qualitative elements. The term projection rather than prediction or forecast generally is used to make clear that the results are conditional on the basic assumptions used. That is, if the basic assumptions of future population, income, consumption patterns, competitive advantage, technological change, etc., are not realized, the projections derived therefrom will be distorted.

This study contains the limitations inherent in any attempt to make long-term projections. While a large number of previous in-depth studies on particular commodities employing statistical or other quantitative techniques have been utilized, the backlog of such research does not cover all areas of interest in a comprehensive study of the entire agricultural economy. The thread which weaves this patchwork of previous studies into a complete fabric of projections is the judgment of specialists in many diverse phases of agricultural research. Unfortunately, results of such analysis are not subject to statements regarding standard errors or confidence limits. Further, there is no guarantee that other informed and competent researchers, given the same information, would arrive at exactly the same results. However, long-range planning can be improved and alternatives better evaluated by using such projections in conjunction with such additional information as may be available.

Projections of the U.S. Economy and U.S. Agriculture, 1980 and 2000

The demand for many agricultural commodities produced in California is nationwide. Therefore, developments in our national economy--such as population growth, income growth and distribution, and level of employment--have a direct impact on California agriculture. Even products produced primarily for in-state markets are affected indirectly by developments in the national economy. For example, population and income in California largely determine in-state demand for farm products but these, in turn, are affected by rates of migration into the State and by the level of industrial activity in the State, both of which are heavily dependent on the national economy. Therefore, projections for California agriculture must proceed within a framework of assumptions regarding the U.S. and world economies.

The Economic Research Service and Forest Service of the U.S. Department of Agriculture [1967] have published a set of projections of U.S. agriculture to 1980, 2000, and 2020, based on the following set of assumptions concerning the national economy:

(1) U.S. population will increase from 194.6 million in 1965 to 235.2 million by 1980 and 308.1 million by 2000 (Series C estimates of the Bureau of the Census).

(2) Total employment will increase from 74.5 million in 1965 to 90.9 million in 1980 and 119.0 million in 2000.

(3) Based on the projected size and productivity of the labor force, the gross national product will increase from $684.9 billion in 1965 to $1,164 billion in 1980 and $2,377 billion in 2000 (in terms of 1965 dollars).

(4) Per capita personal income will increase from approximately $2,769 in 1965 to $3,840 in 1980 and $5,965 in 2000 (in terms of 1965 dollars).

(5) Consumption patterns will shift toward products with higher income elasticities as incomes increase--away from lower cost, starchy foods toward more costly high protein and processed foods.

(6) Exports will increase at the same rate as during the 1950-60 decade. (This may be low for feed grains and vegetables if recent trends continue.)

(7) Projected prices for farm products generally will fall in the range of recent years.

Based on the above general assumptions and on the work of Daly and Egbert [1966a, 1966b] and others, the USDA [1967] has made projections of the quantities which would be required from U.S. agriculture to meet prospective demand in 1980 and 2000. The conceptual framework underlying these projections is that of general price equilibrium. The price equilibrium for each commodity takes into account both the prices of competing products in supply and demand and the supply and demand shifters over time. The major demand shifters are population and per capita income. In high income countries such as the United States, the growth of domestic demand for food is primarily dependent on population growth. However, as per capita incomes increase, people substitute higher value, more nutritious foods such as meat, fruits, and vegetables for lower cost carbohydrate foods.1/ Trends in per capita consumption unrelated to income effects were also incorporated into the projections. For example, despite lower prices and rising incomes the per capita uses of eggs and pork have declined. These demand shifts appear to be related to health considerations, rural-to-urban population shifts, and possibly other factors. The major shifter of agricultural supply is

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1/ Quantification of this phenomenon is provided in empirical estimates of income elasticities of demand. Estimates for certain fruits and vegetables are given in Tables 21 and 22. Income elasticity of demand is defined as the percentage change in quantity demanded per 1 percent change in per capita income, the influence of other variables held constant. The income elasticities for many farm products are positive; i.e., as real incomes rise, per capita consumption increases. However, certain farm products such as wheat, dry beans, potatoes, and sugar exhibit negative income elasticities of demand--income and per capita consumption changes historically have been negatively correlated after the effects of price have been eliminated.

new technology--hybrid seed, fertilizers, insecticides, and other disease controls, improved machinery, improved livestock feeding practices, etc.

Table 1 shows historical and projected (1980) per capita consumption of a range of agricultural products as presented by Daly and Egbert [1966b]. Changes in consumption patterns often are quite pronounced. For example, in 1949-51, the per capita consumption of pork and beef (including veal) was about the same; by 1980 per capita pork consumption is projected to be only half that of beef. Per capita increases in chicken and turkey consumption are projected, but historical downtrends in per capita consumption of eggs and milk are expected to continue. Within the crop category, moderate per capita increases are projected for fruits and vegetables. (The 1964 consumption of fruit was low primarily because of earlier freeze damage on citrus.) Declines are projected in per capita consumption of dry beans, peas, and wheat. Most other commodities are projected to change only slightly in per capita consumption.

The USDA study cited above [1967] has incorporated the above and other studies to make aggregate 1980 and 2000 projections for U.S. agriculture. Per capita consumption projections for individual agricultural commodities were held unchanged beyond 1980. This assumption was made primarily because of the difficulty of projecting the influence of new products and changes in consumer tastes, but also was based on the assumption that further increases in personal income beyond the 1980 level would have little significant influence on per capita consumption of agricultural products. The demand and supply components for commodities and commodity groups were brought together by price equilibrium models. In general, the projected equilibrium prices of farm products derived by this method fell in the range of farm prices in the early 1960's. Livestock prices were projected to increase slightly and crop prices to decline slightly. However, on balance, price levels projected for farm products as a whole were close to 1965 levels. The projections of the aggregate demand-supply quantities--i.e., the quantities of agricultural commodities supplied (required) from U.S. agriculture to meet demand at equilibrium (near-constant) prices--are shown in Table 2 for those individual products or commodity groupings of relevance to California.

TABLE 1

U.S. Per Capita Consumption of Agricultural Products, 1949-51, 1959-61, 1964, and Projections to 1980

Commodity	Year			
	1949-51	1959-61	1964	1980 projected
	pounds per capita[a]			
Livestock				
Beef and veal (carcass weight)	71.2	91.3	106.6	117.0
Pork, excluding lard (carcass weight)	70.6	64.9	65.4	58.0
Lamb and mutton (carcass weight)	3.8	4.8	4.2	3.5
Chicken and turkey (ready-to-cook)	24.9	35.7	38.5	45.5
Eggs (number)	391.0	337.0	314.0	290.0
Milk (equivalent on fat solid basis)	733.0	657.0	636.0	570.0
Crops				
Food fats and oils (actual weight basis)	47.6	48.8	50.7	49.5
Fruits (fresh equivalent)	202.4	194.4	177.5	206.0
Vegetables (fresh equivalent)	201.2	204.9	200.2	216.0
Potatoes (white)	115.0	110.0	110.2	110.0
Dry beans and peas	9.0	8.0	8.4	7.5
Wheat	221.0	165.0	159.3	143.0
Rice	7.6	8.1	10.1	10.0
Corn	51.3	46.2	53.0	52.0
Other cereals	10.1	10.0	10.5	9.6
Sugar, raw value	104.0	104.0	103.0	104.0
Coffee, green bean equivalent	17.6	15.9	15.3	16.0

[a] Except for eggs which are number per capita.

Source: Daly and Egbert [1966b].

TABLE 2

Production of Agricultural Commodities: United States, 1961-65 Average, With Projections of Production Requirements to 1980 and 2000

Commodity	U.S. production 1961-65	U.S. projected production requirements		Index of U.S. projected production	
		1980	2000	1980	2000
	1,000 tons[a/]			1961-65 = 100	
Feed grains					
Corn	106,253	141,500	178,400	133	167
Oats	15,417	17,800	15,800	115	102
Barley	9,758	12,300	12,200	126	125
Sorghum	15,355	25,600	37,700	167	246
Food crops					
Wheat	36,460	56,208	63,825	154	175
Rice (rough)	3,405	4,165	4,680	122	137
Sugar (raw)	3,882	7,300	11,400	188	294
Dry beans	937	1,145	1,445	122	154
Potatoes	13,626	15,955	21,030	117	154
Fruits					
Citrus	7,592	11,000	14,100	145	186
Noncitrus	10,568	12,600	17,200	119	163
Tree nuts (unshelled)	270	371	537	138	199
Vegetables	21,114	30,795	40,090	146	190
Cotton	3,734	4,042	4,702	108	126
Livestock and products					
Milk	62,830	69,686	90,745	111	144
Beef and veal	16,229	22,753	30,294	140	187
Pork	9,967	12,974	16,995	130	171
Lamb and mutton	709	815	1,082	115	153
Farm chickens	583	698	912	120	156
Turkeys	893	1,706	2,224	191	249
Broilers	3,665	5,132	6,646	140	181
Eggs	64,080	72,613	95,251	113	149

a/ With the exception of eggs, for which the unit is 1,000 eggs.

Source: 1961-65 data from U.S. Department of Agriculture [1961-68]; 1980 and 2000 projections from Economic Research Service and Forest Service, U.S. Department of Agriculture, [1968a, Appendix Table 1, adjusted].

Procedure for Projecting California Crop and Livestock Production

The U.S. projections in Table 2 are taken as a point of departure in making most of the California crop projections. Reducing national economy dimensions into those of a single state, however, poses formidable methodological and data problems. California producers and processors of farm products compete with their counterparts in other regions in meeting the national demands for food and fiber. Similarly, California agriculture must compete with other sectors of the California economy for the use of land, water, capital, and labor resources. Only a general equilibrium model of the economy would adequately portray these multiproduct, multiregion, multisector, and multitime relationships. Such a project would require research resources far beyond those available to the authors.1/

Given the limitations of research results now available, crop projections for California rely largely on projections of trends in key parameters such as population, income, yields per acre, and market shares. Specifically, the procedures are as follows:

(1) U.S. production "required" to meet demand at equilibrium prices in 1980 and 2000 is taken from the USDA study, as reported in Table 2.

(2) California's share of the U.S. production of each product or commodity category is projected based on the State's historical share of the market; if that share has been changing either upward or downward over time, the share is projected to continue changing in the same direction but at a decreasing rate, reaching a stable percentage share by 1980. In essence, this procedure is based on the premise that economic forces have favored a change in the market shares by region but that, in an exchange economy, counterforces such as changing resource prices will tend to stabilize the system over time. If there is no discernible trend in California's market share for a product, the projection is taken to be equal to the 1961-65 average share.

(3) Probable future yield levels of individual California crops are estimated, based on the judgment of crop specialists and historical trends.

1/ For related studies on some of the individual components of such a formulation, however, see: Shumway, *et al.* [1970], George and King [1969], Kip and King [1970], and Demir and Carter [1969].

(4) Projections of the acreage "required" for crop production in California is based upon the above projections of output requirements and per acre yields.

California's livestock industries are less clearly related to national demand than most crop production, as is explained in the section on livestock projections for California. These projections are derived as follows:

(1) Outputs to meet 1980 and 2000 demands for California livestock products are estimated individually. California's production of milk and eggs is expected to be determined primarily by demand from within the State. Projected State outputs of individual meat and poultry products are based primarily on evidence from previous research studies, past trends, and judgment of future prospects.

(2) Production per animal or bird and feed efficiency are projected based on previous studies, trends, and the judgment of livestock specialists.

(3) Total production, per animal or per bird production, and feed efficiency are combined to estimate projected livestock and poultry numbers and total feed utilization.

Given the above independent crop and livestock projections to 1980 and 2000, two kinds of balances can be made. The first is a balance between the State's production of feed grains and hay and the aggregate demands for these feeds by the State's livestock industries. Thus, the State's potential surplus or deficit position in principal livestock feeds can be estimated. The second balance is between the demand (requirements) for land and water by agriculture in the State and the potential supply of land and water for agricultural purposes, given expected urbanization of agricultural lands and prospective new irrigation developments.

CROP PROJECTIONS FOR CALIFORNIA, 1980 AND 2000

Tables 3, 4, and 5 provide detailed projections for individual field crops, vegetables, fruits, nuts, and grapes, based on the general procedures outlined above. The left-hand portions of Tables 3, 4, and 5 give projections of U.S. production. In general, these are taken from the USDA study [1967] summarized in Table 2. However, some exceptions and clarifications should be noted. The projection of required U.S. sugar beet production to meet demand in Table 3 shows a less dramatic increase than the projection for raw sugar in Table 2 because the share of the total sugar supply projected to come from beets is expected to continue to decline. The projections for individual feed

TABLE 3

Field Crops: Actual Production, 1961-65, and Projections of Harvested Acreage, Yield, and Production to 1980 and 2000, United States and California[a]

Crop	U.S. production			California as per cent of U.S. production			California production			California yield per acre[a]			California harvested acreage		
	1961-65	1980	2000	1961-65	1980	2000	1961-65	1980	2000	1961-65	1980	2000	1961-65	1980	2000
	1,000 tons			per cent			1,000 tons			tons			acres		
Sugar beets	20,720	27,560	43,100	28.31	28.31	28.31	5,866	7,802	12,201	20.40	24.00	27.60	285,900	325,083	442,065
Wheat	36,460	56,148	63,805	0.72	0.50	0.50	262	281	319	0.87	1.20	1.53	301,000	234,167	208,497
Rice	3,405	4,165	4,680	22.45	22.45	22.45	764	935	1,051	2.40	3.25	4.10	318,200	187,708	256,412
Dry beans	937	1,145	1,445	16.70	15.00	15.00	157	172	217	0.72	0.80	0.88	217,200	214,688	246,587
Potatoes	13,626	15,955	21,030	11.14	11.14	11.14	1,518	1,777	2,343	15.00	19.00	23.00	101,300	93,547	101,859
Safflower	308	NA	NA	83.44	NA	NA	257	481	581	0.97	1.32	1.67	260,600	364,394	347,904
Alfalfa seed	67	94	132	34.59	34.59	34.59	23	32	46	0.20	0.20	0.20	114,400	160,274	226,200
Cotton	3.73	4.03	4.70	11.74	13.50	13.50	0.44	0.54	0.64	0.55	0.65	0.75	764,600	837,692	846,667
Corn	106,523	149,872	185,516	0.22	0.40	0.40	234	599	742	2.22	3.10	3.98	103,400	193,226	186,432
Oats	15,417	9,860	12,205	0.60	0.63	0.63	93	62	77	0.76	0.96	1.16	123,400	64,583	66,379
Barley	9,758	9,860	12,205	17.98	17.98	17.98	1,754	1,773	2,194	1.21	1.40	1.59	1,447,000	1,266,429	1,379,874
Grain sorghum	15,355	27,608	34,174	3.22	3.22	3.22	494	889	1,100	1.96	2.38	2.80	250,400	373,529	392,857
Alfalfa hay	--	--	--	--	--	--	6,224	6,908	8,520	5.36	6.00	6.65	1,161,400	1,151,333	1,281,203
Other hay	--	--	--	--	--	--	1,187	1,306	1,623	1.74	2.12	2.51	683,200	616,000	647,000
Other field crops[b]	--	--	--	--	--	--	--	--	--	--	--	--	149,800	149,800	149,800
Total, all field crops	--	--	--	--	--	--	--	--	--	--	--	--	6,281,800	6,332,453	6,779,736

[a] California yields calculated as a simple five-year average. Therefore, average acreage times average yield only approximately equals total production.

[b] Includes silage, flax, hops, ladino and red clover seed, and sweet potatoes.

Source: U.S. projections from U.S. Department of Agriculture, Economic Research Service and Forest Service [1967]. California projections by authors.

TABLE 4

Vegetables, Melons, and Strawberries: Projections of Harvested Acreage, Yield and Production to 1980 and 2000, United States and California

Crop	Unit of production	U.S. production			California as percent of U.S. production			California production			Unit of yield	California yield per acre[a]			California total harvested acreage		
		1961-65	1980	2000	1961-65	1980	2000	1961-65	1980	2000		1961-65	1980	2000	1961-65	1980	2000
Tomatoes																	
Processing	1,000 tons	4,567	7,398	9,637	58.99	65.00	65.00	2,694	4,809	6,264	tons	18.8	30	34	143,760	160,308	184,232
Fresh	1,000 cwt.	20,625	30,112	39,188	29.30	28.00	28.00	6,044	8,432	10,973	cwt.	177	220	262	34,140	38,327	41,882
Subtotal	1,000 cwt.	111,965	178,072	231,928	53.51	58.75	58.75	59,924	104,612	136,253	--	--	--	--	177,900	198,635	226,114
Dark green and deep yellow																	
Broccoli	1,000 cwt.	2,285	3,336	4,342	74.21	90.00	90.00	1,696	3,002	3,908	cwt.	66	77	89	26,720	38,987	43,910
Carrots	1,000 cwt.	16,934	24,724	32,175	36.06	38.00	38.00	6,106	9,395	12,226	cwt.	271	336	385	22,580	27,961	31,756
Peppers, bell	1,000 cwt.	3,947	5,763	7,499	20.77	23.00	23.00	820	1,325	1,725	cwt.	162	170	199	5,080	7,794	8,668
Spinach	1,000 cwt.	3,962	4,200	5,468	36.36	41.00	41.00	1,441	1,722	2,242	cwt.	165	190	220	8,740	9,063	10,191
Subtotal	1,000 cwt.	27,128	38,023	49,484	37.09	40.62	40.62	10,063	15,444	20,101	--	--	--	--	63,120	83,805	94,525
Other vegetables																	
Artichokes	1,000 cwt.	528	1,045	1,357	100.00	100.00	100.00	528	1,045	1,357	cwt.	62	85	93	8,480	12,294	14,591
Asparagus	1,000 cwt.	3,631	4,611	5,991	52.32	45.00	45.00	1,900	2,075	2,696	cwt.	30	35	39	63,760	59,286	69,128
Beans, snap	1,000 cwt.	13,882	20,268	26,376	6.70	3.00	3.00	931	608	791	cwt.	103	50	63	9,200	12,160	12,556
Beans, lima	1,000 cwt.	1,937	2,828	3,680	45.90	45.90	45.90	889	1,298	1,689	cwt.	33	33	37	26,960	39,333	45,649
Brussels sprouts	1,000 cwt.	707	1,032	1,343	91.37	91.37	91.37	646	943	1,227	cwt.	123	123	139	5,220	7,667	8,827
Cabbage	1,000 cwt.	23,070	27,915	36,220	10.81	10.81	10.81	2,493	3,018	3,915	cwt.	226	230	259	11,040	13,122	15,116
Cauliflower	1,000 cwt.	2,543	3,484	4,526	60.67	73.00	73.00	1,543	2,543	3,305	cwt.	98	105	118	15,660	24,219	28,008
Celery	1,000 cwt.	14,354	19,234	24,976	53.62	55.00	55.00	7,696	10,579	13,737	cwt.	552	552	624	13,900	19,165	22,014
Corn, sweet	1,000 cwt.	13,184	16,612	21,622	9.72	8.00	8.00	1,282	1,329	1,730	cwt.	68	68	77	18,820	19,544	22,468
Cucumbers	1,000 cwt.	13,466	20,872	27,201	11.27	11.27	11.27	1,517	2,352	3,066	cwt.	222	230	259	6,780	10,226	11,838
Garlic	1,000 cwt.	350	511	665	100.00	110.00	100.00	350	511	665	cwt.	104	130	144	3,880	3,931	4,618
Lettuce	1,000 cwt.	38,955	56,874	74,014	58.60	65.00	65.00	22,826	36,968	48,110	cwt.	198	250	276	115,740	147,872	174,312
Onions	1,000 cwt.	25,827	37,707	49,071	18.20	27.00	27.00	4,700	10,181	13,249	cwt.	335	350	394	14,000	29,089	33,627
Peas, green	1,000 cwt.	10,642	15,537	20,220	5.04	4.00	4.00	537	621	809	cwt.	35	35	40	14,400	17,743	20,225
Subtotal	1,000 cwt.	163,076	228,530	297,262	29.33	32.41	32.41	47,838	74,071	96,346	--	--	--	--	327,840	415,651	482,977
Melons																	
Cantaloupes	1,000 cwt.	12,679	15,342	19,906	53.92	60.00	60.00	6,836	9,205	11,944	cwt.	137	150	161	50,140	61,367	74,186
Honeydews	1,000 cwt.	1,333	1,946	2,533	77.94	77.94	77.94	1,039	1,517	1,974	cwt.	145	150	162	7,170	10,113	12,185
Watermelons	1,000 cwt.	29,286	36,608	47,736	8.99	7.00	7.00	2,634	2,563	3,342	cwt.	171	180	194	15,380	14,239	17,227
Subtotal	1,000 cwt.	43,298	53,896	70,175	24.27	24.60	24.60	10,509	13,285	17,260	--	--	--	--	72,690	85,719	103,598
Other miscellaneous	1,000 cwt.	33,878	55,312	71,918	--	--	--	--	--	--	--	--	--	--	41,580	41,580	41,580
Strawberries	1,000 cwt.	5,100	7,446	9,690	42.82	42.82	42.82	2,184	3,188	4,149	cwt.	225	420	460	9,820	7,590	9,020
Total commercial vegetables, melons, and strawberries	1,000 cwt.	384,445	561,279	730,457	33.95	37.53	37.53	130,518	210,600	274,109	--	--	--	--	692,950	832,980	957,814

a/ California yields calculated as a simple 5-year average. Therefore, average acreage times average yield only approximately equals total production.

Sources: U.S. projections from: U.S. Department of Agriculture, Economic Research Service and Forest Service [1967]. California projections by authors.

TABLE 5

Tree Fruits, Nuts, and Grapes: Projections of Harvested Acreage, Yield, and Production to 1980 and 2000, United States and California

Crop	U.S. production			California as percentage of U.S. production			California production			California yield per acre[a]			California bearing acres			California total bearing and nonbearing acreage		
	1961-65	1980	2000	1961-65	1980	2000	1961-65	1980	2000	1961-65	1980	2000	1961-65	1980	2000	1961-65	1980	2000
	1,000 tons			percent			1,000 tons			tons per acre			acres					
Citrus fruits[b]																		
Oranges	5,130	8,516	11,030	21.71	21.71	21.71	1,114	1,849	2,395	8.88	10.02	11.80	125,650	184,531	202,966	175,863	258,266	284,067
Lemons	599	851	1,108	91.15	80.00	80.00	546	680	887	11.56	14.72	17.03	47,305	46,196	52,085	51,055	49,861	56,217
Grapefruit	1,626	2,423	3,154	7.50	9.00	9.00	122	218	284	10.60	15.69	17.81	11,423	13,894	15,946	14,088	17,136	19,667
Subtotal	7,355	11,790	15,292	24.23	23.30	23.32	1,782	2,747	3,566	--	--	--	184,378	244,621	270,997	241,006	325,263	359,951
Semitropical fruits																		
Avocados	53	76	99	82.20	82.20	82.20	44	62	81	2.12	3.39	3.79	20,872	18,289	21,372	23,101	20,242	23,655
Dates	22	27	35	100.00	100.00	100.00	23	27	35	5.56	7.73	8.79	4,153	3,493	3,982	4,556	3,832	4,368
Figs	65	66	86	100.00	100.00	100.00	65	66	86	3.29	3.29	3.92	19,796	20,061	21,939	20,984	21,265	23,225
Olives	51	62	80	100.00	100.00	100.00	51	62	80	1.82	1.82	2.17	28,242	34,066	36,866	32,121	38,747	41,931
Subtotal	191	231	300	95.81	93.94	94.00	183	217	282	--	--	--	73,063	75,909	84,159	80,762	84,086	93,179
Deciduous fruits																		
Apples	2,959	4,202	5,445	8.20	8.20	8.20	244	345	446	11.45	15.06	18.04	21,299	22,908	24,723	26,407	28,401	30,651
Apricots	200	248	322	95.50	98.00	98.00	191	243	316	5.25	6.63	7.99	36,450	36,652	39,549	41,549	41,778	45,080
Cherries	273	341	442	9.60	9.60	9.60	26	33	42	2.46	2.46	3.10	10,735	13,415	13,548	13,940	17,420	17,593
Nectarines	61	99	129	100.00	100.00	100.00	61	99	129	6.60	8.61	10.33	9,226	11,498	12,488	10,262	12,790	13,891
Peaches, clingstone	747	1,258	1,631	100.00	100.00	100.00	747	1,258	1,631	12.90	15.50	18.85	57,938	81,161	86,525	76,816	107,944	115,078
Peaches, freestone	1,040	1,029	1,335	29.50	29.50	29.50	307	304	394	9.00	10.80	13.14	34,223	28,148	29,985	38,010	31,244	33,283
Pears	614	761	989	49.20	45.00	45.00	302	343	445	8.92	12.50	14.82	33,865	27,440	30,027	46,600	37,760	41,320
Plums	101	125	150	100.00	100.00	100.00	101	125	150	4.18	5.15	6.24	24,116	24,272	24,030	29,265	29,454	29,160
Prunes, dried weight	180	234	295	85.00	88.46	90.85	153	207	268	1.76	2.02	2.49	85,712	102,475	107,631	113,084	135,209	142,012
Subtotal	6,175	8,297	10,738	34.53	35.64	35.58	2,132	2,957	3,821	--	--	--	313,564	347,969	368,506	395,933	442,000	468,068
Tree nuts[c]																		
Almonds	64.5	227.5	310.3	100.00	100.00	100.00	64.5	227.5	310.3	0.66	0.91	1.07	97,389	250,000	290,000	130,774	280,000	325,000
Walnuts	80.2	142.8	190.8	95.00	98.00	98.00	76.5	140.0	187.0	0.61	0.70	0.85	125,639	200,000	220,000	157,602	225,000	250,000
Subtotal	144.7	370.3	501.1	97.44	99.24	99.24	141.0	367.5	497.3	--	--	--	223,028	450,000	510,000	288,376	505,000	575,000
Grapes	3,623	4,348	5,652	91.20	91.20	91.20	3,303	3,965	5,155	7.38	9.22	11.07	447,058	430,043	465,673	479,021	460,777	498,953
TOTAL	17,488.7	25,036.3	32,483.1	43.12	40.95	41.01	7,541.0	10,253.5	13,321.3	--	--	--	1,241,091	1,548,542	1,699,335	1,485,098	1,817,126	1,995,151

a/ California yields calculated as a simple five-year average. Therefore, average bearing acreage times average yield only approximately equals total production.

b/ Does not include limes, tangelos, and tangerines.

c/ Does not include pecans and filberts.

Source: U.S. projections from U.S. Department of Agriculture, Economic Research Service and Forest Service [1967]. California projections by authors.

grains in Table 3 differ somewhat from those in Table 2, though the total tonnage of all feed grains remains the same. The projections in Table 3 reflect the judgment that grain sorghum and corn will increase their share of the total feed grain supply (relative to oats and barley) at a faster rate than projected in the USDA study.

The USDA study provides United States projections for vegetables only as a single category--increases of 46 percent by 1980 and 90 percent by 2000 over the 1961-65 base period (Table 2). These percentage increases--with the exception of processing tomatoes which were projected independently--are adopted as projections for each major vegetable category (tomatoes, dark green and deep yellow vegetables, other vegetables, melons, miscellaneous, and strawberries) in Table 4. However, trends in per capita consumption and, therefore, changing shares of the market by individual vegetables within a category, were taken into account in making the projections for each commodity.

The USDA study gives United States projections only for citrus and noncitrus fruits. Because of their importance in California agriculture, a further breakdown is desirable as shown in Table 5. The United States projection for citrus in Table 2 appears clearly too low since the 1980 projection was exceeded in 1966-67. Therefore, United States citrus production was projected at the higher level shown in Table 5, reflecting increased per capita consumption and, very likely, equilibrium prices at lower levels than those assumed in the USDA study. The 1980 U.S. projections for the other categories (semitropical, deciduous, and grapes) are close to those projected by Farrell [1969], reflecting slight per capita increases in deciduous fruit consumption and slight per capita decreases in consumption of semitropical fruits and grapes. As in the case of vegetables, the projections for individual fruits take into account changing consumption shares within each category. These shares are assumed to stabilize by 1980. Projections for 2000 were increased uniformly by 30 percent over 1980, based on the USDA study. The assumption is that per capita consumption roughly stabilizes by 1980 so that subsequent consumption increases are attributable only to population growth.

The USDA indexes of projected change in tree nut production (Table 2) for almonds and walnuts appear far too low on the basis of large new plantings of these crops in California. Therefore, acreages of almonds and walnuts were projected independently on the basis of new plantings already made, plus a modest rate of additional plantings annually to 1980 and 2000. The quantities of nuts forthcoming clearly will far exceed the USDA projections in Table 2. It is therefore likely that prices will fall, the magnitude depending critically on the export market, particularly for almonds.

The projected percentage shares of the U.S. market to be supplied by California are shown, by commodity, in Tables 3, 4, and 5. The rationale for this procedure as a means of reflecting interregional competition was discussed above. The California production for each commodity shown in the tables is calculated simply as projected U.S. production times the projected share of the market supplied by California.

State Yield Projections

The yield projections in Tables 3, 4, and 5 have drawn on a number of sources, including Shumway and Stults [1969], unpublished research by McKusick, statistical analyses by the authors, and the judgments of agricultural research scientists at the University of California at Davis. The general procedure was to make tentative statistical projections of yields to 1980 based on linear or curvilinear time trend equations, whichever appeared most appropriate from a statistical and logical point of view. In the case of the most important crops, specialists were then asked to judge whether these yield estimates should be modified on the basis of additional qualitative information regarding new technology, prospective rates of farmer adoption of technology, changes in location of production within the State, and other yield-influencing factors. The assumptions underlying the projections were made explicit in each case as follows:

(1) Yield estimates for 1980 are to be the most likely level of State average yield based on technology presently known by research workers and new technology expected to be available and broadly adopted in 1980.

(2) Price-cost relationships are to remain at 1961-65 average levels (e.g., the ratio of fertilizer cost to product price to remain at 1961-65 levels).

(3) Normal weather and growing conditions in the target year 1980.

In most cases, the trend equation projections to 1980 were accepted by research specialists as reasonable approximations to the most likely State average yields in that year; in other cases, some modification appeared warranted.

Projecting yields to the year 2000 was done uniformly for each field crop by simply assuming that the absolute change in yield from 1980 to 2000 would equal the projected change from 1961-65 to 1980. In effect, this assumes that technology will permit continued yield increases to year 2000 at only a slightly lower rate than projected for the next decade. The same procedure was applied to fruits, nuts, grapes, and vegetables, with the modification that the group weighted average yield index (individual crop yield index weighted by 1961-65 average acreage) from 1961-65 to 1980 was applied to each individual commodity within the group in projecting yields to 2000.1/ The only exceptions to this procedure were for processing tomatoes and strawberries. In both cases, the rate of yield increase from 1961-65 to 1980 is not expected to continue to 2000. Because of radical technological changes under way, yield increases for processing tomatoes to 1980 are expected to equal the rapid rate experienced in the 1944-55 period; from 1980 to 2000, the rate of increase is expected to return to the 1955-68 pace. For strawberries, yields have increased rapidly in recent years due to changes in technology; yields in 1968 were 50 percent above the 1961-65 average. A rapid rate of yield increase is expected to continue to 1980 as the industry completes a conversion to annual summer plantings to avoid virus problems. Thereafter, further increases are projected at a much lower rate.

Projecting yields into the future, particularly for so far distant as the year 2000, is obviously hazardous. Agricultural technology has accounted for steady increases in crop yields in California in the past. On the basis of known technology not yet fully adopted, yield increases for another decade seem assured. Beyond this period, the projections reflect the judgment that there are many potential yield-increasing technologies which are yet to be exploited but which will be developed over time. More efficient use of known technology is also expected as management becomes better informed and more scientific throughout agriculture. However, one should be aware of the uncertainties involved in such assumptions. For example, if more rigid environmental and antipollution controls are enacted and enforced in California, as

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1/ For example, yield projections to 2000 for almonds and walnuts (tree nuts group) were made as follows: The weighted average yield index for tree nuts was 125--138 for almonds (weighted by 1961-65 acreage of almonds) and 115 for walnuts (weighted by 1961-65 acreage of walnuts). The 1961-65 average yield for each crop was then multiplied by 0.25 and this amount added to the 1980 projected yield of that crop to obtain the yield projection for 2000.

seems quite likely, restrictions may be placed on levels or methods of agricultural fertilization, spraying, burning, and other cultural practices. Furthermore, air, soil, and water pollution could have a deleterious effect on agricultural yields in some areas. Our assumption, however, is that developments in agricultural technology will permit growers sufficient flexibility to obtain substantial yield increases within the probable environmental conditions and the restraints likely to be placed on agricultural production by society.

State Acreage Projections

The right-hand portions of Tables 3, 4, and 5 provide projections of California harvested acreages in 1980 and 2000. These acreages are derived as a residual, or balancing figure, from specific projections of U.S. demand, California's market share position, and yields per acre. Any errors in these assumptions would reflect themselves directly in the acreage projections. Thus, the acreage projections should be viewed as the logical result of a set of plausible but uncertain values derived from other key variables. The acreage projections for minor individual commodities within a group are particularly sensitive to misspecifications of the basic demand and yield assumptions.

Changes for Specific Crops

The following discussion interprets more fully some of the individual crop projections of Tables 3, 4, and 5, including some indications of prospective shifts in location within the State. Past trends indicate rather dynamic shifts in the location of particular California crops;1/ current developments suggest further important acreage shifts in the future.

Feed grains.--The United States projections in Table 3 show that corn and grain sorghum are the major feed grains and are expected to increase in relative importance in the future. In California, on the other hand, barley has traditionally been the major feed grain, followed by grain sorghum, corn, and oats; in 1961-65 barley accounted for nearly 25 percent of the field crop

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1/ More details on past crop trends are available in Johnston and Dean [1969].

acreage in the State. However, the general shift toward corn and grain sorghum in the United States also is expected to take place in California. Corn acreage in California has already (1967) recovered from the abnormally low acreages of the 1961-65 period. New single cross-hybrids and the increasing demand for corn for food consumption appear to be important factors in the recovery of State corn production. Grain sorghum as an irrigated crop is also expected to increase. New hybrids with high yields and early maturity are especially well suited to double-cropping (usually with barley or vegetables). Grain sorghums may also expand as a reclamation crop on newly developing lands of the west side of the San Joaquin Valley. Future barley acreage may be considerably reduced beyond the figures shown in Table 3 if Mexican wheat continues to develop as a feed grain in California. In many areas, Mexican wheat appears to give higher yields than barley at comparable costs. Therefore, if the feeding industry widely accepts Mexican wheat as a feed grain at prices equivalent to those for barley, a substantial shift could occur. The projections for barley in Table 3 should, therefore, be considered as a total for barley and Mexican wheat, the proportions between the two depending on the degree of acceptance of wheat as a feed grain. (The wheat acreage projection in Table 3 excludes Mexican wheat.)

As will be shown later, California is now and will likely continue to be a substantial importer of feed grains. California's import position, together with the fact that it produces less than 2 percent of the U.S. feed grain output, means that State acreage could change substantially with little change in price. As in the past, therefore, the acreage of feed grains in California is likely to be determined largely by competitive relationships with other crops such as cotton, rice, safflower, and, in some areas, specialty crops.

Food grains.--Table 3 shows that California rice acreage is projected to decline somewhat from 1961-65 levels. Although U.S. production is projected to increase and California is expected to maintain its share of production, yield increases are projected to increase so rapidly that less State acreage will be required to meet future demand. Of course, if the yield projections are too high, acreage will be correspondingly underestimated. The critical factor affecting rice production has been and will probably continue to be the nature of federal control programs. In the case of rice, these have been largely conditioned recently by the level of rice shipments to Asia; the high acreage for California was 432,000 acres in 1968 when shipments to Vietnam were at their peak. Even in peacetime, the California rice industry is particularly dependent on the export market, since a high proportion of the California crop is not consumed domestically. In the long-term future, the level of U.S. and California rice production will depend on the success of new varieties (developed by the International Rice Research Institute in the Philippines) in making Asia self-sufficient or a net exporter of rice. The California rice industry is expected to concentrate even further in the Sacramento Valley where adapted soils, low water costs, and processing facilities are available.

California's acreage of wheat (aside from Mexican wheat which was discussed as a feed grain) is also projected to decline from 1961-65 levels. Because wheat is generally in a poor competitive position with respect to other grains in California cropping systems (except where wheat of milling quality can be grown), California's share of U.S. wheat production is projected to continue declining to 1980. Again, actual future U.S. production will depend on the world wheat situation and the U.S. export position.

Cotton.--Table 3 shows that California cotton acreage is projected to increase slightly to 1980 and 2000. This projection is based on an increase in U.S. production, a slightly higher share of the U.S. output produced in California (equal to 1966-67 average share), and moderate yield increases. Here again, acreage and production will be largely dependent on future government control programs which have been in effect in some form continuously since 1954. There is growing evidence that the cotton program may be in for a major revision in the near future. The United States has always been the world's leading cotton exporter but exports in recent years have been falling as mills in Britain and elsewhere have turned more largely to synthetic fibers. Substitution of synthetics for cotton is also evident in the domestic market, as is discussed in more detail on pages 103-107. An additional factor is the likelihood of some form of limitation on government payments to individual producers which could have a substantial impact on large growers. Since cotton is currently the key high value crop in many parts of the San Joaquin Valley and the Imperial Valley, a substantial reduction in its competitive position could lead growers there to search for other high value alternatives such as tree crops, vines, and vegetables, with possible price depressing effects. Thus, if cotton acreage is not maintained at about the current level as shown in Table 3, the acreage of high value alternatives may exceed those projected here.

Sugar beets.--California sugar beet acreage is projected to increase somewhat by 1980 and substantially by 2000 (Table 3). The increased California acreage is heavily dependent on the U.S. projection that domestic sugar production will more than double by 2000. The U.S. projection, in turn, depends on a high level of self-sufficiency assumed under the provisions of the Sugar Act. It is assumed that a larger share of the domestic supply will come from cane sources in the future. California's share of the beet portion of total demand is projected to remain about constant because of acreage controls. Should the high U.S. projections fail to materialize, California acreage would be reduced accordingly.

Alfalfa hay and seed.--The production of alfalfa hay in California (Table 3) is derived from feed requirements for California livestock as estimated later in this report. It is assumed that a low value, bulky product such as hay will be produced mainly within California, with only minor inshipments from Arizona. Given moderate increases in yields, the projected alfalfa hay acreage in 1980 remains at about the 1961-65 level, with an increase of about 130,000 acres between 1980 and 2000.

Alfalfa seed acreage is projected to increase substantially in the State, but this is based on projected constant yields per acre; California alfalfa seed yields have changed little since the early 1950's. However, the acreage is now concentrating among experienced, knowledgeable growers; and, if new developments such as improved strains of bees for pollination prove successful, yields could increase sharply. Unless California should improve its share of the U.S. market in such a case--not an unlikely development--California's acreage increase would be less dramatic than shown in Table 3.

Safflower.--Safflower production is projected to increase substantially in California but with only moderate acreage increases because of strong yield increases. The U.S. Department of Agriculture [1967] has projected vegetable oil production (here defined as oil from soybeans, peanuts, and flaxseed and omitting cottonseed and corn oil) to increase 88 percent by 1980 and 127 percent by 2000 compared with the 1961-65 base period. Safflower oilseed production as a percentage of U.S. vegetable oil production has been relatively constant in the past six to seven years. Therefore, California production was also projected to increase by 88 percent and 127 percent to the projection dates (Table 3). Safflower is a relatively new commercial crop in California and, therefore, important changes could take place in marketing or production which might markedly affect its position in the State. For example, new varieties high in oleic acid are being introduced in California, perhaps leading to expansion in markets for which the current varieties high in linoleic-fatty acid oils do not compete.

Dry beans.--California is the second ranking state in bean production, accounting for all of the U.S. production of large lima, baby lima, and garbanzo beans, plus large shares of small white, blackeyes, and pink and red kidney beans. As a whole, U.S. dry bean production is projected to increase very little by 1980 and only moderately to 2000. California's share is projected to decline slightly which, together with yield increases, leads to little change in acreage (Table 3).

Potatoes.--The per capita consumption of potatoes has stabilized as usage of potato chips, dehydrated potatoes, and frozen potatoes has increased sufficiently to offset declines in fresh potato consumption. A relatively high percentage of the California crop goes to the fresh market because of seasonal considerations. California is therefore expected to maintain its share of the market. Yield increases will probably just about offset demand so that projected acreage remains about constant (Table 3).

Vegetables.--Processing tomatoes are by far the most important single vegetable crop, accounting for around 20 percent of the State vegetable crop acreage. Primarily because mechanization of the crop has been successful, California's share of U.S. production has risen since the 1961-65 base period and is projected to stabilize at about 65 percent. Sharp increases in tomato yields are projected for the next decade as growers become more experienced with mechanized harvesting and as other improvements in cultural practices are adopted. Thus, the sharp increase in demand is projected to be met with only moderate increases in California acreage (Table 4).

It would be impractical to attempt to discuss the projections for each vegetable crop individually. The method of projection has been set forth above and used rather mechanically. Therefore, the individual crop projections are very tentative and provided in Table 4 for purposes of completeness. A more detailed discussion of trends in California production of individual vegetable crops is available in Johnston and Dean [1969].

There have been some shifts in the location of particular vegetable crops (mainly processed vegetables) to the San Joaquin Valley in recent years. The trend is expected to continue, particularly with the development of new irrigated acreage on the west side. However, the Central Coast and Southern California areas, despite pressures from urbanization, have roughly maintained their total vegetable acreage because of seasonal advantages not directly paralleled in other parts of the State and nation.

Citrus fruits.--The U.S. projections for citrus "production requirements" in Table 2 appear low in view of recent acreage developments. In fact, the level of citrus requirements projected for 1980 was exceeded by production in the favorable weather year 1966. With normal weather conditions, U.S. citrus production appears likely to expand greatly in the next decade, together with a probable decline in citrus prices. On the basis of these developments, the 1980 index of citrus production (1961-65 = 100) was increased from 145 to 160; this is still somewhat below the level of 168 projected to 1980 by Farrell [1969]. Oranges are expected to comprise a slightly larger share of total citrus consumption at the expense of lemons, grapefruit, and other citrus fruits. Urbanization in the orange producing areas of Southern California, together with competition with Florida-produced processed oranges, led to a long-term downtrend in California's acreage and share of U.S. orange production. However, California's share of U.S. orange production appears to have leveled off (with annual fluctuations due to weather conditions) at around 22 percent. Bearing acreage is up somewhat since 1965 for both California Valencias and navels and new plantings in the San Joaquin Valley will result in sharp increases in bearing acreage in the next few years. In fact, nonbearing orange acreage in 1967 was almost exactly half the bearing acreage in that year. Assuming that California will maintain its recent average share of U.S. production and attain moderate yield increases, the State orange acreage is projected to increase from about 175,000 acres in 1961-65 to 260,000 acres in 1980 and 285,000 acres by 2000; bearing acreage is projected at 185,000 acres in 1980 and 203,000 acres in 2000.

Lemon acreage in the State is projected to change very little (Table 5), primarily because of the increasing share of the market being supplied by Arizona. Conversely, California acreage of grapefruit is projected to increase, primarily because of a projected increase in California's share of the U.S. market.

Semitropical fruits.--California produces essentially the entire U.S. output of fruits in this category. Acreages are projected to change little, with yield increases about offsetting the upward shift in demand. Olive acreages are projected to increase substantially between 1961-65 and 1980 predicated on a constant yield level (Table 5); while yields have varied drastically from year to year, there has been little general upward trend in the last 20 years. However, new high yielding plantings in parts of the San Joaquin Valley could change this picture when they become full bearing.

Deciduous fruits.--In terms of acreage, peaches (mainly clingstone) and prunes are the major crops in the deciduous fruit category. The acreages of both are projected to increase substantially while acreages of the other fruits are projected to increase relatively little (Table 5). Clingstone peaches are well adapted to California Central Valley areas and processing facilities are well developed in this area. Thus, California's share of the U.S. market is expected to increase, leading to substantial production and acreage increases in the State.

Prunes are well adapted to mechanical picking and new plantings in the Sacramento Valley suggest that the upward projection in acreage is reasonable. While the acreages of the other deciduous fruits change little in aggregate, this obscures some rather dramatic shifts of location of acreage within the State. The acreages of apricots, cherries, and prunes in particular are shifting rapidly out of the Central Coast areas into the San Joaquin Valley and the Sacramento Valley. The pressure of urbanization in the San Francisco Bay area counties and other coastal areas has forced growers out and, in general, they have relocated in favorable areas of the Central Valley. The deciduous fruit acreage in Southern California has steadily declined over time for the same reasons and will soon become an insignificant portion of the State total.

Tree nuts.--As mentioned earlier, the rapid recent plantings of almonds and walnuts suggest that the U.S. production projections shown in Table 2 will almost certainly be exceeded. Therefore, future acreage projections were revised, based on existing bearing and nonbearing acreage and a projected decreased rate of additional new plantings over time. Thus far, the export market has absorbed the increased supply of almonds at favorable prices. Loyns [1969] estimates very high price elasticities of demand for almonds in the domestic and foreign markets which leads to some optimism that the sharp increases in supply can be marketed at prices only moderately lower than current levels. The key to future prices clearly lies in the rather uncertain export market. Limited foreign supplies, import quality restrictions, and tariffs from 20 to 30 percent have protected domestic walnut prices. Successful mechanization of walnuts has been an important spur to new plantings in recent years. Given the prospective increases in California acreage and production of walnuts, a greater dependency in the future on foreign market outlets is not unlikely.

Grapes.--California produces over 90 percent of the U.S. grape crop. Three general categories--raisin, wine, and table grapes--are produced in California and sold in highly interrelated markets. Raisin varieties, predominately Thompson Seedless, account for two-thirds of the State acreage, but nearly 40 percent of the production of Thompson Seedless goes into the wine outlet, along with 90 percent of the wine grapes and some table grapes. The overall projection for grapes is for nearly a constant acreage, with yield increases about offsetting changes in demand. However, there may be a substantial change in varietal classes. For example, the increasing demand for higher quality wines in the United States may lead to increased acreages of moderate yielding, higher quality wine varieties in the San Joaquin Valley.

Summary of State Field Crop, Tree, Vine, and Vegetable Acreage Projections

The above set of projected crop acreages for 1980 and 2000 are summarized by individual crop and crop category in Table 6. Comparisons are provided with the average annual acreage in the 1961-65 base period as well as with acreages for the most recent years of available data, 1966 through 1968. It is apparent in several cases that the directions and/or magnitudes of the long-term projections run counter to the experience in the 1966-68 period. For example, food grain (wheat and rice) acreage has increased considerably since the 1961-65 base period, whereas the long-term projections show declines in acreage. The explanation is that acreage allotments of rice in California were expanded in the 1966-68 period because of shipments of rice to the Far East as a result of the Vietnam war; such shipments are considered temporary and not part of the permanent demand structure for U.S. rice employed in projecting acreages in the United States and California.

TABLE 6

Summary of California Crop Acreages of Field Crops, Vegetables, Tree Fruits, Nuts, and Grapes: Projections to 1980 and 2000 Compared with 1961-65 Average and 1966-68 Annual Averages

Crop category	Harvested acreage[a]						Percentage change	
	1961-65 average actual	1966 actual	1967 actual	1968 actual	1980 projected	2000 projected	1961-65 average to 1980	1961-65 average to 2000
	acres						percent	
Field crops								
Feed grains	1,924,200	1,985,000	2,179,000	2,036,000	1,897,767	2,025,542	- 1.37	5.26
Food grains	619,200	630,000	710,000	811,000	521,875	464,909	-15.71	-24.91
Sugar beets	285,900	269,700	200,800	254,000	325,083	442,065	13.70	54.62
Cotton	764,600	618,000	588,000	687,000	837,692	846,667	9.55	10.73
Dry beans	217,200	223,000	189,000	214,000	214,688	246,587	- 1.15	13.52
Potatoes	101,300	114,000	110,300	92,100	93,547	101,859	- 7.65	0.55
Safflower	260,600	341,000	300,000	165,000	364,394	347,904	39.82	33.50
Alfalfa seed	114,400	105,000	97,000	98,000	160,274	226,200	40.09	97.72
Alfalfa hay	1,161,400	1,141,000	1,164,000	1,152,000	1,151,333	1,281,203	- 0.86	10.31
Other hay	683,200	654,000	733,000	712,000	616,000	647,000	- 9.83	- 5.92
Other field crops	149,800	137,900	139,800	130,100	149,800	149,800	0.00	0.00
Subtotal	6,281,800	6,218,600	6,410,900	6,351,200	6,332,453	6,779,736	0.80	7.92
Vegetables								
Tomatoes	177,900	195,000	219,300	263,200	198,635	226,114	11.65	27.10
Dark green and deep yellow	63,120	67,400	72,500	79,800	83,805	94,525	32.77	49.75
Other vegetables	327,840	331,500	344,900	355,900	415,651	482,977	26.78	47.32
Melons	72,690	64,000	68,000	77,650	85,719	103,598	17.92	42.52
Other misc. vegetables	41,580	40,400	39,320	40,150	41,580	41,580	- 0.00	- 0.00
Strawberries	9,820	7,800	8,000	8,600	7,590	9,020	-22.70	- 8.14
Subtotal	692,950	706,100	752,020	825,300	832,980	957,814	20.20	38.22
Tree fruits, nuts, and grapes								
Citrus fruits	241,006	263,540	269,530	288,751	325,263	359,951	34.96	49.35
Semitropical fruits	80,762	75,260	75,650	76,504	84,086	93,179	4.11	15.37
Deciduous fruits	395,933	393,760	392,410	389,755	442,000	468,068	11.64	18.22
Tree nuts	288,376	341,690	356,120	384,385	505,000	575,000	75.11	99.39
Grapes	479,021	489,890	486,740	477,554	460,777	498,953	- 3.80	4.16
Subtotal	1,485,098	1,564,140	1,580,450	1,616,949	1,817,126	1,995,151	22.36	34.34
TOTAL	8,459,848	8,489,640	8,743,370	8,793,449	8,982,559	9,732,701	6.18	15.04

[a] Includes bearing plus nonbearing acreage for tree fruits, nuts, and grapes.

Source: Tables 3, 4, and 5.

Cotton acreage in California in the 1966-68 period has been below the 1961-65 level whereas the long-term projection in Table 6 is for an increase in acreage. In this case, the projected increase in California acreage is based on a U.S. production level which may be overoptimistic in view of competition from man-made fibers. (See further discussion on cotton on pages 103-107). The level of this projection is important because cotton is located on some of the prime land in the State, where sharp changes in the cotton acreage would affect the acreage levels of alternative crops.

The tomato acreage projection would appear to be an underestimate relative to data for 1966 to 1968. However, the large increases in canning tomato acreage in 1968 led to large carry-overs and acreages have since been reduced. Also, substantial yield increases are expected, thus reducing the acreage increase required to meet demand.

Table 6 shows that from 1961-65 to 1980 the acreage of field crops is projected to remain about constant, while vegetable acreage increases about 20 percent and tree fruit, nut, and grape acreage increases about 22 percent. In terms of harvested acreages of these crops, the 1980 projection is about 0.5 million acres above the 1961-65 average acreage, with increases of 140,000 acres of vegetables, 332,000 acres of tree fruits, nuts, and grapes, and only about 50,000 acres of field crops. Thus, the composition of the State crop acreage to 1980 shows an intensification toward the higher valued specialty crops.

From 1980 to 2000, the projected increases in tree, vine, and vegetable acreages are less dramatic--an additional 178,000 acres of trees and vines and 125,000 acres of vegetables between 1980 and 2000. These lower rates of increase reflect primarily a leveling off in the projected per capita consumption of these commodities as incomes reach higher levels. On the other hand, field crop acreage is projected to increase by nearly 450,000 acres between 1980 and 2000. This increase reflects primarily additional feed grains and hay to support higher livestock production and increases in sugar beet and alfalfa seed acreages. As will be pointed out later, the projections for feed grains and hay could well be too high, particularly if beef cattle feeding and cotton production continue to decline. Also, as land and water costs in California increase, the comparative advantage of growing many of the lower valued field crops is likely to shift to other parts of the United States. Thus, the projected increase of field crops to 2000 is based on a number of conditions which could be altered considerably in 30 years.

LIVESTOCK PROJECTIONS FOR CALIFORNIA, 1980 AND 2000

Most major California crops such as cotton, sugar beets, rice, fruits, nuts, and vegetables comprise a substantial proportion of total U.S. production. The markets for these crops are therefore nationwide and California's future production can be reasonably projected as a share of U.S. total demand as was done in the previous section. This procedure, however, is not justified for many livestock products since California is in a strong deficit position in meat products.

Projections of California production of milk and eggs can be reasonably tied to growth in California demand. Although some dairy products are shipped between states and while California has recently exported a small percentage of her egg production, the high cost of transporting bulky perishable items such as fluid milk and fresh eggs suggests that major interstate shipment as a continuing practice is unlikely. Therefore, future milk and egg production are assumed to depend primarily on California population increases and California projected per capita consumption.

A suitable projection basis is less evident for meat products. California presently imports about 40 percent of the beef, 98 percent of the pork, and 70 percent of the broiler meats consumed in the State; California is an exporter only of turkeys. All of these products are easily shipped between states and, with the exception of turkeys, California's share of total U.S. production is relatively small. For this reason, the projections of beef cattle, sheep, hog, broiler, and turkey production are based on recent trends modified by judgment concerning possible future changes in the competive position of California in producing these products.

On the basis of detailed livestock projections, it is possible to approximate future utilization by livestock of feed grains, by-product feeds, hay, and pasture and to compare these with the estimates of California feed production developed independently and presented earlier in Table 3. Taken together, the two sets of projections provide an estimate of future feed production-livestock consumption balances and required feed imports under one plausible set of assumptions. The sensitivity of these balances is also examined under alternative assumptions regarding some of the key variables.

A recent study by Snider and King [1970] provides estimates of the feed utilization, by type of feed and livestock category, and the balance with feed production in California for the period 1961-65. Thus, for the first time, a reasonably accurate and internally consistent set of estimates of feed production and utilization is available for California. Starting with these estimates for the base period, 1961-65, projections of feed utilization per head of livestock have been made to 1980 and 2000 based on general assumptions of increased feed efficiency for livestock adapted from Landsberg, Fischman, and Fisher [1963] as shown in Table 7. Although both medium and high efficiency assumptions are included, the medium assumptions appear most likely and are used, in general, in determining feed requirements in the subsequent California livestock projections.

Dairy Cattle

The dairy projections to 1980 and 2000 draw on the work of Forker [1965] and Siebert [1967] with modifications and extensions. Per capita consumption of class I milk in California has been steadily falling but at a declining rate, from a high of about 320 pounds in 1956-57 to about 280 pounds in 1967. It is projected that per capita class I usage will level off at 270 pounds by 1980 and remain constant to 2000. On the other hand, the percentage of California milk production going into class I usage has increased from around 58 percent in the early 1950's to about 64 percent in 1967. It is projected that this percentage will level off at about 66 percent in 1980 and remain constant to 2000. These assumptions, taken together with a California population of 26.5 million in 1980 and 38.6 million in 2000, lead to a total milk production of 10,984 million pounds in 1980 and 16,012 million pounds in 2000, or increases of 31 percent and 91 percent, respectively, over the 1961-65 base period.

Milk production per cow has increased at a near linear rate from 7,700 pounds per cow in 1952 to 11,150 pounds per cow in 1967 with the rate of increase showing signs of slackening only in the past five years. Assuming that additional increases will come at a decreasing rate, the projections are for a 12,500-pound-per-cow average for California in 1980 and 13,250 pounds per cow in 2000. With these rates of production per cow, the above projected milk production for California can be met with 965,000 cows in 1980 and 1,208,000 cows in 2000--increases of 10 percent and 38 percent, respectively,

TABLE 7

Feed Efficiency (Pounds Corn Equivalent Per Pound Output Or Per Egg) for Livestock, Projected to 1980 and 2000

Livestock category	Medium efficiency		High efficiency	
	1980 index	2000 index	1980 index	2000 index
	1961-65 = 100			
Cattle and calves	91	91	81	78
Hogs	91	86	80	73
Milk	92	83	84	75
Poultry	86	81	74	69
Eggs	85	68	70	53

Source: Adapted from Landsberg, Fischman, and Fisher [1963], Table 12-1, Part B, p. 242.

over the base period, 1961-65. It might be added that past projections of California milk production per cow have usually been far too conservative. If the present projections incorporate this same underestimate, the required number of cows to meet prospective demand would, of course, be correspondingly lower.

Table 8 summarizes dairy cattle numbers, feed requirements per head, and total feed requirements for the dairy industry for the 1961-65 base period together with projections to 1980 and 2000. The 1961-65 feed requirements per head are from Snider and King [1970]. Total feed requirements are obtained by multiplying these feed requirements by the number of dairy animals in each class in 1961-65. Projections to 1980 and 2000 are derived under the following assumptions:

(1) milk cow numbers (cows plus heifers, two years and older) are as derived above;

(2) the number of animals in the other categories retain the same proportions to cows as the 1961-65 period; and

(3) feed requirements per head remain at the 1961-65 level.

The last assumption may appear questionable in that substantially higher milk production per cow is obtained with the same amount of feed used in 1961-65. However, the increase in feed efficiency implied by these assumptions is equal to the high feed efficiency projections for 1980 shown earlier in Table 7 and midway between the medium and high feed efficiency projections for 2000. Furthermore, the concentrate levels in Table 8 have been shown to be sufficient to support the higher milk output per cow on well managed California farms with high quality cows and using high quality alfalfa hay. With increasing emphasis on selection of high producing cows, heavier culling, and disease control, the above projections appear quite plausible as future industry averages.

Beef Cattle

The beef cattle feedlot industry has expanded rapidly in California in the postwar years. In the past decade alone, cattle and calves marketed from California feedlots increased from about 1.3 to 2.2 million head. The number of feedlots has declined but the average size of the remaining lots has increased substantially so that total feedlot capacity has greatly expanded.

TABLE 8

California Dairy Cattle Numbers, Feed Requirements Per Head and Total Feed Requirements, 1961-65 Average and Projected to 1980 and 2000

Year	Type of animal	Number per 100 cows	Total number per year a/	Feed requirements per head per year b/						Total feed requirements					
				Feed grains	High protein by-products	Other by-products	Total concentrate	Hay c/	Pasture	Feed grains	High protein by-products	Other by-products	Total concentrate	Hay c/	Pasture
			1,000 head	pounds					AUM's	1,000 tons					1,000 AUM's
1961-65 average	Cows and heifers ≥ 2 years	100.0	877	1,246.5	364.9	1,361.2	2,972.6	10,795	4.50	546.6	160.0	596.9	1,303.5	4,733.6	3,947
	Heifers, 1-2 years	27.7	243	275.0	100.7	343.1	718.8	3,650	5.60 AUM	69.2	25.3	86.3	180.8	443.5	1,361
	Heifer calves	29.6	260					900	annual					117.0	1,456
	Steer and bull calves	2.6	23	--	--	--	--	900	average	--	--	--	--	10.4	129
	Bulls	1.5	13	--	--	--	--	9,000	↓	--	--	--	--	58.5	73
	TOTAL	--	--	--	--	--	--	--	--	615.8	185.3	683.2	1,484.3	5,363.0	6,966
1980	Cows and heifers ≥ 2 years	100.0	965	Same as above for 1961-65						601.4	176.1	656.8	1,434.3	5,208.6	4,343
	Heifers, 1-2 years	27.7	267							76.0	27.8	94.9	198.7	487.3	1,495
	Heifer calves	29.6	286											128.7	1,602
	Steer and bull calves	2.6	25							--	--	--	--	11.3	140
	Bulls	1.5	14							--	--	--	--	63.0	78
	TOTAL	--	--							677.4	203.9	751.7	1,633.0	5,898.9	7,658
2000	Cows and heifers ≥ 2 years	100.0	1,208	Same as above for 1961-65						752.9	220.4	822.2	1,795.5	6,520.2	5,435
	Heifers, 1-2 years	27.7	335							95.3	34.9	118.9	249.1	611.4	1,876
	Heifer calves	29.6	358											161.1	2,005
	Steer and bull calves	2.6	31							--	--	--	--	14.0	174
	Bulls	1.5	18							--	--	--	--	81.0	101
	TOTAL	--	--							848.2	255.3	941.1	2,044.6	7,387.7	9,591

a/ Data for 1961-65 from California Crop and Livestock Reporting Service [1968a]. Numbers by category similar to those reported in Shultis and Gordon [1959]. Projections by authors, see text.

b/ Snider and King [1970].

c/ Does not include silage.

Practically all of the beef cattle fed in the State are fattened in large-scale establishments, finishing an average of about 1.6 lots per year as of 1963, according to Hopkin and Kramer [1965]. Total beef consumption in California has also expanded rapidly in this period. Thus, despite the rapid expansion of fed cattle in the State, the numbers marketed from California feedlots supply only about half the total number of head required to meet California consumption. The remaining supply is met by inshipments of live and dressed beef and by dairy animals slaughtered as a by-product of the dairy industry.

Daly and Egbert [1966b] projected U.S. per capita consumption of beef and veal to increase from about 100 pounds in the 1961-65 base period to 117 pounds in 1980. On the basis of data from a study by the ERS, USDA [1967], the authors have projected per capita consumption to increase to 126 pounds by 2000. Hopkin and Kramer [1965] report that California consumption of beef is 30 percent higher than the national average. Assuming that this difference remains to 1980 and 2000, California per capita consumption of beef and veal would be 152 pounds and 164 pounds, respectively. Using Hopkin and Kramer's [1965] estimated carcass weight for beef of 590 pounds and given California's projected population, approximately 6.8 million head of beef cattle would be required to meet California demand in 1980 and 10.7 million head to meet demand in 2000. If California were to continue to supply around 50 percent of these figures, feedlot numbers would need to increase from around 2.0 million head in 1961-65 to 3.4 million in 1980 and 5.3 million head in 2000. Increases in feedlot numbers of these magnitudes do not appear likely. King and Schrader [1963] showed that the Southern and Great Plains areas have substantial cost advantages over California in beef feeding, primarily because of lower feed grain costs and feeder calf availability. Historically, California has remained competitive through greater feed efficiency and larger-scale lots than other areas. It appears doubtful that such an advantage can be maintained indefinitely over comparable large-scale lots now developing in Texas, Oklahoma, Nebraska, Colorado, and other areas. A recent USDA study [1970] reported a net increase of 36 feedlots in the United States in 1969 with a capacity of over 16,000 head per year. The net increases by state were Texas (17), Kansas (12), Colorado (3), Oklahoma (2), and Arizona (2). California had no net increase, although there was a decrease by three lots in the 16,000-32,000 head capacity category and an increase by three lots in the over 32,000 head capacity category. Cattle marketings from California feedlots have also declined by about 200,000 head from the 1965 high of nearly 2.3 million head.

The weight of evidence indicates a probable slowing down of the sharp uptrend in California feedlot marketings experienced over the past decade. A reasonable projection for 1980 appears to be 2.5 million head, an increase of approximately 0.4 million over numbers in 1967 and 0.2 million over the peak number in 1965. This would imply a drop from around 50 percent in the 1961-65 period to 37 percent in 1980 in the share of California beef consumption coming from California feedlots. (The share in 1967 was around 45 percent.)1/ Assuming a further drop in this share to 30 percent by 2000 would imply feedlot marketings of 3.2 million head. Although California feedlot projections cannot be made with great confidence, they are important in calculating future feed production-consumption balances in California. Therefore, the feed implications of alternative feedlot numbers are examined in the section on projected feed-livestock balances in California.

In recent years, inshipments of stockers and feeders have been slightly over twice the number of calves raised in the State. Increasing substantially the number of calves produced off range appears unlikely in view of the keen competition in grazing areas, particularly at higher elevations, by recreation, water development, and timber interests. These factors, coupled with the fact that cattle ranching generally returns low profits,2/ suggest only a limited possibility for expansion in range cattle numbers in the State. Thus, it is assumed that beef calves raised in California as a percent of feedlot marketings will continue to drop from 40 percent in 1961-65 to 37 percent in 1980 and 2000. With a calf crop of 88 percent, this implies beef cow numbers increasing from 889,000 head in 1961-65 to 1,049,000 and 1,342,000 in 1980 and 2000, respectively.

Table 9 shows the 1961-65 numbers of beef animals, by category with projections to 1980 and 2000 as indicated above. Feed requirements for 1961-65

1/ Hopkin and Kramer [1965], however, project that feedlot capacity in California would be adequate to produce 48 percent of the State's supply in 1975, or 2.64 million head.

2/ For example, see Dean, Finch, and Petit [1966] and Ching [1967].

TABLE 9

California Beef Cattle Numbers, Feed Requirements Per Head and Total Feed Requirements, 1961-65 Average and Projected to 1980 and 2000

				Feed requirements per head per year[b]						Total feed requirements					
Year	Type of animal	Number per 100 cows	Total number per year [a]	Feed grains	High protein by-products	Other by-products	Total concentrate	Hay	Pasture	Feed grains	High protein by-products	Other by-products	Total concentrate	Hay	Pasture
			1,000 head	pounds					AUM's	1,000 tons					1,000 AUM'
1961-65 average	Cattle fed in feedlots	--	1,957	1,482.0	84.0	784.0	2,350.0	584	--	1,450.0	82.2	767.1	2,299.3	571.4	--
	Beef cows, 2 years and over	100.0	889	22.5	90.0	--	112.5	2,000	11.70	10.0	40.0	--	50.0	889.0	10,401
	Heifer replacements, 1-2 years	34.6	308	--	--	--	--	1,400	↑	--	--	--	--	215.6	1,725
	Calves raised	(88.3)	(785)	--	--	--	--	--	5.60 AUM	--	--	--	--	--	--
	On feed	22.5	200	600.0	225.0	--	825.0	1,425	annual	60.0	22.5	--	82.5	142.5	--
	Other	65.8	585	--	--	--	--	--	average	--	--	--	--	--	3,276
	Bulls	7.8	69	--	--	--	--	1,400	↓	--	--	--	--	48.3	386
	TOTAL	--	--	--	--	--	--	--	--	1,520.0	144.7	767.1	2,431.8	1,866.8	15,788
1980	Cattle fed in feedlots	--	2,500	1,348.6	76.4	713.4	2,138.4	531	--	1,685.8	95.5	891.8	2,673.1	663.8	--
	Beef cows, 2 years old and over	100.0	1,049	20.5	81.9	--	102.4	1,820	11.70	10.8	43.0	--	53.7	954.6	12,273
	Heifer replacements, 1-2 years	34.6	363	--	--	--	--	1,274	↑	--	--	--	--	231.2	2,033
	Calves raised	(88.3)	(926)	--	--	--	--	--	5.60 AUM	--	--	--	--	--	--
	On feed	22.5	236	546.0	204.8	--	750.8	1,297	annual	64.4	24.2	--	88.6	153.0	--
	Other	65.8	690	--	--	--	--	--	average	--	--	--	--	--	3,864
	Bulls	7.8	82	--	--	--	--	1,274	↓	--	--	--	--	52.2	459
	TOTAL	--	--	--	--	--	--	--	--	1,761.0	162.7	891.8	2,815.5	2,054.8	18,629
2000	Cattle fed in feedlots	--	3,200	Same as for 1980					--	2,157.8	122.2	1,141.4	3,421.4	849.6	--
	Beef cows, 2 years old and over	100.0	1,342						11.70	13.8	55.0	--	68.7	1,221.2	15,701
	Heifer replacements, 1-2 years	34.6	464						↑	--	--	--	--	295.6	2,598
	Calves raised	(88.3)	(1,185)						5.60 AUM	--	--	--	--	--	--
	On feed	22.5	302						annual	82.4	30.9	--	113.4	195.8	--
	Other	65.8	883						average	--	--	--	--	--	4,945
	Bulls	7.8	105						↓	--	--	--	--	66.9	588
	TOTAL	--	--						--	2,254.0	208.1	1,141.4	3,603.5	2,629.1	23,832

[a] Data for 1961-65 from California Crop and Livestock Reporting Service [1968a]. Projections by authors, see text.

[b] Data for 1961-65 from Snider and King [1970]. Projections based on medium feed efficiency projections of Landsberg, Fischman, and Fisher [1963], see earlier Table 6.

have been estimated by Snider and King [1970]. Projections of feed requirements to 1980 and 2000 shown in Table 9 are based on the medium level gains of feed efficiency (1980 and 2000 index = 91, 1961-65 = 100) shown earlier in Table 7.

Sheep and Lambs

Sheep production in California has declined gradually over the past decade, with mature ewe numbers dropping from about 1.4 to 1.2 million. Strong competition for available range land from beef cattle, as well as from non-agricultural uses, has been a factor in reducing numbers. Most of the lambs from these flocks are fed out within the State, although the numbers have been supplemented with annual inshipments of around 350,000 head of stocker and feeder lambs.

Almost all of California's fed lambs are finished on pasture rather than being fed in drylot.[1/] Pasture feeding results in cheaper gains than drylot feeding because of high concentrate prices. The principal lamb feeding areas of the State are Imperial Valley, where lambs are fed over the winter on alfalfa pasture and vegetable and sugar beet aftermath feeds, and the Sacramento Valley, where a larger percentage are fed on summer irrigated pasture as well as on grain, beet, or vegetable aftermath feeds. In general, however, lamb feeding is not in a strong competitive positon for land resources in the irrigated areas and consequently numbers fed have dropped in the past decade from about 1.3 to 1.0 million head.

With the above picture in mind, the downward trend in mature ewe numbers has been projected to level out at 1,150,000 head in 1980 and remain constant to 2000. Lamb feeding is projected to contract proportionately. The resulting numbers are reported in Table 10, together with feed requirements per head and total requirements. Since most of the feeding is on pasture and aftermath grazing, no increase in feed efficiency is assumed in 1980 and 2000.

Hogs

Hog production in California has been declining steadily since World War II. In the past decade, the number of pigs saved annually in the State has

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[1/] For a general discussion of the California sheep industry, see Spurlock [1968].

TABLE 10

California Sheep and Lamb Numbers, Feed Requirements Per Head and Total Feed Requirements, 1961-65 Average and Projected to 1980 and 2000

				Feed requirements per head per year b/						Total feed requirements					
Year	Type of animal	Number per 100 ewes	Total number per year a/	Feed grains	High protein by-products	Other by-products	Total concentrate	Hay	Pasture	Feed grains	High protein by-products	Other by-products	Total concentrate	Hay	Pasture
			1,000 head	pounds					AUM's	1,000 tons					1,000 AUM's
1961-65 average	Ewes, 1 year and over	100.0	1,293	--	--	--	--	16	2.35	--	--	--	--	10.3	3,039
	Feedlot lambs	2.3	30	42.0	--	36.0	78.0	240	--	0.6	--	0.5	1.2	3.6	--
	Lambs and yearlings on pasture	87.2	1,127	--	--	--	--	--	1.00	--	--	--	--	--	1,127
	Ewe lamb replacements c/	20.0	259	--	--	--	--	16	2.30	--	--	--	--	2.1	596
	Rams and ram replacements	3.8	49	--	--	--	--	16	2.30	--	--	--	--	.4	113
	TOTAL	--	--	--	--	--	--	--	--	0.6	--	0.5	1.2	16.4	4,875
1980 and 2000	Ewes, 1 year and over	100.0	1,150							--	--	--	--	9.2	2,703
	Feedlot lambs	2.3	26							0.5	--	0.5	1.0	3.1	--
	Lambs and yearlings on pasture	87.2	1,003	Same as for 1961-65						--	--	--	--	--	1,003
	Ewe lamb replacements c/	20.0	230							--	--	--	--	1.8	529
	Rams and ram replacements	3.8	44							--	--	--	--	0.4	101
	TOTAL	--	--							0.5	--	0.5	1.0	14.5	4,336

a/ Data for 1961-65 from California Crop and Livestock Reporting Service [1968a]. Projections by authors, see text.

b/ Snider and King [1970].

c/ 20 percent replacement rate for ewes, 1 year and over.

halved, reaching a level of about 260,000 in 1966 and 1967. Over the same period, the percentage of total California hog slaughter coming from pigs raised in the State has dropped from about 25 percent to 15 percent. Major factors in the decline are high concentrate prices in California relative to the Midwest and a decline in garbage-fed hogs in the State.

The long-term downtrend in the number of California pigs saved appears to have leveled off somewhat in recent years (although numbers dropped sharply in 1968). The authors have projected a slight further decline to 250,000 head in 1980 and 2000 as shown in Table 11. Feed efficiencies in 1980 and 2000 are expected to improve to the rates shown earlier in Table 7.

Poultry

The poultry industry is comprised of three distinct enterprises: egg production, turkey production, and broiler and fryer production. Separate projections are made for each.

Egg Production

In the past decade, California's estimated per capita egg consumption has exceeded that of the United States by about 22 eggs. Projections by the Economic Research Service, U.S. Department of Agriculture [1967] show U.S. per capita egg consumption declining to 308 per capita in 1980 and 2000. Retaining the 22 egg per capita difference for California results in a projected consumption of 330 eggs per capita in the State. Taking into account California population increases, correcting for hatching eggs, and assuming a return to self-sufficiency rather than exporting around 5 percent of California eggs, as has been the case in recent years, total egg production in California would increase from about 6,837 thousand annually in 1961-65 to 8,527 thousand in 1980 and 12,430 thousand in 2000.

Egg production per layer in California has been consistently above the U.S. average until the past few years when the margin has narrowed until the two figures were nearly equal in 1967. United States egg production per layer is projected to continue increasing but at a decreasing rate from 225 annually in 1961-65 to 235 in 1980 and 250 in 2000. Adopting the same rates per layer for California leads to increases in the number of layers for egg production

TABLE 11

California Hog Numbers, Feed Requirements Per Head, and Total Feed Requirements, 1961-65 Average and Projected to 1980 and 2000

Year	Type of animal	Number per 100 pigs saved	Total number per year a/	Feed requirements per head per year b/									
				Feed grains	High protein by-products	Other by-products	Total concentrate	Hay	Feed grains	High protein by-products	Other by-products	Total concentrate	Hay
			1,000 head	pounds					pounds				
1961-65 average	Pigs saved	100	308	--	--	--	--	--	--	--	--	--	--
	Pigs fed out	72	222	985.0	128.0	35.0	1,148.0	33	109.3	14.2	3.9	127.4	3.7
	TOTAL	--	--	--	--	--	--	--	109.3	14.2	3.9	127.4	3.7
1980	Pigs saved	100	250	--	--	--	--	--	--	--	--	--	--
	Pigs fed out	72	180	896.4	116.5	31.8	1,045.0	30	80.7	10.5	2.9	94.0	2.7
	TOTAL	--	--	--	--	--	--	--	80.7	10.5	2.9	94.0	2.7
2000	Pigs saved	100	250	--	--	--	--	--	--	--	--	--	--
	Pigs fed out	72	180	847.1	110.1	30.1	987.3	28	76.2	9.9	2.7	88.9	2.5
	TOTAL	--	--	--	--	--	--	--	76.2	9.9	2.7	88.9	2.5

a/ Data for 1961-65 from California Crop and Livestock Reporting Service [1968a]. Projections by authors, see text.

b/ Data for 1961-65 from Snider and King [1970]. Includes feed for breeding stock. Projections based on medium feed efficiency projections of Landsberg, Fischman, and Fisher [1963], see earlier Table 6.

from 29.9 million annually in 1961-65 to 35.8 million in 1980 and 49.3 million in 2000. These numbers, together with per bird and total feed requirements appear in the first row of each section of Table 12. Projections of per bird feed requirements to 1980 and 2000 were derived from the medium increases in feed efficiency shown earlier in Table 7.

Broiler Production

United States consumption of broiler meat is projected to increase from 7.3 billion pounds annually in 1961-65 to 10.3 billion pounds in 1980 and 13.3 billion pounds in 2000, according to a study by the ERS, USDA [1967]. California broiler production has increased from around 150 to 250 million pounds in the past decade. However, U.S. production has increased even faster, causing California's share to drop slightly below 3 percent. Because of the intense competition from low cost broilers shipped in from the Southeast, California's share of U.S. production is projected to decline slightly and level off at about 2.5 percent in 1980. However, large scale aggressive broiler producers in California should be able to continue to compete favorably with inshipments.

Given the U.S. projection, California's share at 2.5 percent and an average market live weight of 3.8 pounds per bird, the numbers of California broilers are projected to increase from 60.1 million annually in 1961-65 to 67.5 million in 1980 and 87.5 million in 2000. These numbers, together with broiler breeding flock numbers are shown in Table 12. Feed requirements per bird in 1961-65 are from Snider and King [1970] with projections to 1980 and 2000 based on the medium feed efficiency projections given earlier in Table 7.

Turkey Production

United States consumption of turkey meat is projected to increase tremendously from 1.8 billion pounds (live-weight basis) annually in 1961-65 to 3.4 billion pounds in 1980 and 4.4 billion pounds in 2000 (Table 2). Substantial increases in consumption have already been observed through 1968. California is presently the leading state in turkey production, supplying 18 percent of the U.S. total production annually in the 1961-65 period. However, this percentage has been declining slightly in the past few years. A study by Bawden, Carter, and Dean [1966] suggests that, because of high priced feed grains and

TABLE 12

California Poultry Numbers, Feed Requirements Per Bird, and Total Feed Requirements, 1961-65 Average and Projected to 1980 and 2000

			Feed requirements per bird per year[b]				Total feed requirements			
Year	Type of poultry	Total number per year [a]	Feed grains	High protein by-products	Other by-products	Total concentrate	Feed grains	High protein by-products	Other by-products	Total concentrate
		1,000 birds	pounds				1,000 tons			
1961-65 average	Layers, annual average[c]	29,943	79.0	19.0	11.0	109.0	1,182.7	284.5	164.7	1,631.9
	Broilers produced	60,115	5.7	2.4	0.7	8.8	171.3	72.1	21.0	264.5
	Broiler breeding flock	427	117.6	29.6	14.3	161.5	25.1	6.3	3.1	34.5
	Turkeys raised	16,386	50.0	17.8	7.7	75.5	409.7	145.8	63.1	618.6
	Turkey breeding flock	961	114.0	39.8	11.6	165.4	54.8	19.1	5.6	79.5
	TOTAL	--	--	--	--	--	1,843.6	527.8	257.5	2,629.0
1980	Layers, annual average[c]	35,835	70.0	16.8	9.7	96.5	1,253.7	301.6	174.6	1,729.8
	Broilers produced	67,520	5.1	2.1	0.6	7.8	171.3	72.1	21.0	264.5
	Broiler breeding flock	450	105.8	26.7	12.9	145.8	23.8	6.0	2.9	32.8
	Turkeys raised	26,254	43.1	15.3	6.6	65.0	565.4	201.2	87.1	853.7
	Turkey breeding flock	1,252	98.1	34.2	10.1	142.2	61.4	21.4	6.3	89.0
	TOTAL	--	--	--	--	--	2,075.6	602.3	291.9	2,969.8
2000	Layers, annual average[c]	49,270	59.5	14.3	8.3	82.1	1,466.6	352.8	204.2	2,023.6
	Broilers produced	87,454	4.8	2.0	0.6	7.4	209.0	88.0	25.6	322.7
	Broiler breeding flock	560	88.6	22.1	11.1	122.1	24.8	6.2	3.1	34.2
	Turkeys raised	34,215	40.7	14.5	6.3	61.5	696.5	247.9	107.3	1,051.6
	Turkey breeding flock	1,559	92.1	32.1	9.4	133.5	71.8	25.0	7.3	104.1
	TOTAL	--	--	--	--	--	2,468.7	719.9	347.5	3,536.2

[a] Data for 1961-65 from California Crop and Livestock Reporting Service [1968b]. Projections by authors, see text.

[b] Data for 1961-65 from Snider and King [1970]. Projections based on medium feed efficiency projections of Landsberg, Fischman, and Fisher [1963], see earlier Table 6.

[c] Feed for breeding flock included.

higher labor costs, California is at a disadvantage with the Midwest and South unless it can achieve offsetting efficiencies in production, processing, and transportation. So far, such efforts appear to have been successful. However, because of the competitive situation, California's share is projected to decline slightly to about 15 percent by 1980 and remain at that level.

Under the above assumptions and an average live-weight projection of 19.5 pounds per bird, California turkey numbers would increase from 16.4 million birds annually in 1961-65 to 26.3 million in 1980 and 34.2 million in 2000. These numbers, together with estimates of the turkey breeding flock requirements, appear in Table 12. Feed requirements per bird are projected to 1980 and 2000 based on the medium feed efficiency projections given earlier in Table 7.

PROJECTED FEED-LIVESTOCK BALANCES IN CALIFORNIA

The foregoing projections for crop and livestock production permit a comparison of expected future supplies of feed grains, hay, and other feeds in California with expected livestock feed requirements. Table 13 is a feed supply and distribution table, employing data primarily from Snider and King [1970] for the 1961-65 base period and providing a summary of projections to 1980 and 2000 from data developed primarily in the preceding tables.

Feed grain imports into California in 1961-65 averaged about 2.1 million tons (Table 13). With feed grain production averaging only about 2.6 million tons annually over this period, imports were thus around 80 percent of State production. Table 13 shows that even if California increases feed grain production to 3.3 million tons in 1980 as projected earlier, imports of feed grains would need to remain at current levels to meet demands from livestock and other sources. Imports would increase to 2.3 million tons by 2000 under the projected conditions.

As pointed out under the discussion of beef cattle projections above, the beef feeding industry in the State is probably the key to future feed grain import levels. The projections for dairy and egg production are tied closely to California population and income growth and these industries should be able to compete effectively at high feed grain prices. The other livestock and poultry categories appear unlikely to grow significantly and, furthermore,

TABLE 13

California Feed Supply and Distribution, 1961-65 Average with Selected Projections to 1980 and 2000

Item	Feed grains	High protein by-products	Other by-products	Total concentrates	Hay	Silage[a/]	Pasture
	1,000 tons						1,000 AUM's
1961-1965							
Beginning stocks	1,587.0	40.3	--	1,627.3	--	--	--
Production	2,573.4	623.2	1,232.4	4,429.0	7,410.6	1,557	27,629
Imports and inshipments	2,111.4	211.1	485.1	2,807.7	166.9	--	--
TOTAL SUPPLY	6,271.8	874.6	1,717.5	8,864.0	7,577.5	1,557	27,629
Livestock feed:							
Dairy cattle	615.8	185.3	683.2	1,484.3	5,363.0	1,557	6,966
Beef cattle	1,520.0	144.7	767.1	2,431.8	1,866.8	--	15,788
Sheep and lambs	0.6	--	0.5	1.2	16.4	--	4,875
Hogs	109.3	14.2	3.9	127.4	3.7	--	--
Poultry	1,843.6	527.8	257.5	2,629.0	--	--	--
Other (residual)	168.8	2.6	2.8	174.1	100.8	--	--
Total	4,258.1	874.6	1,715.0	6,847.8	7,350.7	1,557	27,629
Ending stocks	1,449.6	--	--	1,449.6	--	--	--
Exports and outshipments	313.0	--	2.5	315.5	226.8	--	--
Seed	91.7	--	--	91.7	--	--	--
Food and industry	159.4	--	--	159.4	--	--	--
TOTAL DISTRIBUTION	6,271.8	874.6	1,717.5	8,864.0	7,577.5	1,557	27,629
Projected 1980[b/]							
Production	3,323.0	c/	c/	c/	8,224.0	1,713	30,623
Imports and inshipments	2,005.1	c/	c/	c/	166.9	--	--
TOTAL SUPPLY	5,328.1	981.9	1,943.8	8,843.9	8,390.9	1,713	30,623
Livestock feed:							
Dairy cattle	677.4	203.9	751.7	1,633.0	5,898.9	1,713	7,658
Beef cattle	1,761.0	162.7	891.8	2,815.5	2,054.8	--	18,629
Sheep and lambs	0.5	--	0.5	1.0	14.5	--	4,336
Hogs	80.7	10.5	2.9	94.0	2.7	--	--
Poultry	2,075.6	602.3	291.9	2,969.8	--	--	--
Other (residual)	168.8	2.6	2.8	174.3	193.2	--	--
Total	4,764.0	982.0	1,941.6	7,687.6	8,164.1	1,713	30,623
Exports and outshipments	313.0	--	2.5	315.5	226.8	--	--
Seed	91.7	--	--	91.7	--	--	--
Food and industry	159.4	--	--	159.4	--	--	--
TOTAL DISTRIBUTION	5,328.1	982.0	1,944.1	8,254.2	8,390.9	1,713	30,623
Projected 2000[b/]							
Production	4,113.0	c/	c/	c/	10,143.0	2,144	37,759
Imports and inshipments	2,345.8	c/	c/	c/	166.9	--	--
TOTAL SUPPLY	6,458.8	1,193.2	2,435.7	10,087.7	10,309.9	2,144	37,759
Livestock feed:							
Dairy cattle	848.2	255.3	941.1	2,044.6	7,387.7	2,144	9,591
Beef cattle	2,254.0	208.1	1,141.4	3,603.5	2,629.1	--	23,832
Sheep and lambs	0.5	--	0.5	1.0	14.5	--	4,336
Hogs	76.2	9.9	2.7	88.9	2.5	--	--
Poultry	2,468.7	719.9	347.5	3,536.1	--	--	--
Other (residual)	247.1	--	--	247.1	49.3	--	--
Total	5,894.7	1,193.2	2,433.2	9,521.1	10,083.1	2,144	37,759
Exports and outshipments	313.0	--	2.5	315.5	226.8	--	--
Seed	91.7	--	--	91.7	--	--	--
Food and industry	159.4	--	--	159.4	--	--	--
TOTAL DISTRIBUTION	6,458.8	1,193.2	2,435.7	10,087.7	10,309.9	2,144	37,759

[a/] Entire state production of silage assumed fed to dairy cattle. Projections to 1980 and 2000 increase in same ratio as other feed inputs for dairy cattle.

[b/] Beginning and ending stocks are assumed to balance. Exports, seed, food and industry uses are held at 1961-65 average levels.

[c/] Not projected individually.

Sources: Snider and King [1970], data from preceding Tables 3 and 6-11, and projections by authors.

with the exception of turkeys, are minor users of the aggregate supply of feed grains in the State. However, the projections for beef cattle feeding in California are extremely uncertain. The future appears to hinge on the rate of development of large, efficient cattle feeding operations in the Great Plains and other areas and on relative freight rates for feed grains, live animals, and dressed meat to California. To illustrate the impact that a change in cattle feeding would have on the demand for feed grains in California, consider two widely divergent cases: (1) Suppose California continues to feed out about 50 percent of the cattle required to meet future State demand. This would require an additional 0.6 million tons of feed grains by 1980 and 1.4 million tons by 2000 beyond the supplies shown in Table 13. The increased demand would be met by some combination of State production and inshipments, probably largely the latter since prices of feed grains in California would not be affected by a larger deficit. (2) Suppose competition from other regions forces the California feedlot industry to stabilize at 2.0 million head (approximately the 1961-65 average). In this case, the State demand for feed grains in 1980 could be met with a decrease of about 0.5 million tons in feed grain inshipments compared with the 1961-65 situation shown in Table 13 or, alternatively, a lower projected increase in California feed grain production.

Table 13 also gives the aggregate demand and supply for by-product feeds which, along with feed grains, comprise the concentrate portion of livestock and poultry rations. No attempt is made to break down the sources of supply of by-product feeds since they are many, varied, and constantly changing.

Hay, silage, and pasture supplies in the State are projected to approximately equal State demand, since interstate movements are likely to be small or nonexistent. Minor supplies of hay are shipped interstate but, for California, these nearly cancel. The State production of hay will continue to be nearly 85 percent alfalfa. For simplification, the entire State production of silage is assumed to be fed to dairy cattle even though minor amounts are actually fed to beef cattle. Pasture requirements for 1980 increase by only about 10 percent--which can be met through continued pasture and range improvement practices such as brush clearance, fertilization, and higher yielding varieties of grasses and clovers. The 38-percent increase in range requirements by 2000 would likely require some increase in acreage unless the rate of range improvement accelerates.

PROJECTED LAND USE AND WATER RESOURCE USE IN CALIFORNIA

Land and water resources available for agriculture--primarily irrigated crop land--constitute the major physical limitations to future production in California. The purpose of this section therefore is to focus on the question: Is the planned rate of irrigation development in California sufficiently rapid, given the projected losses of agricultural land to urbanization, to provide the levels of irrigated acreage "required" to meet California's share of the projected future demand for food and fiber?[1/] The discussion is divided into three major subsections. First, the harvested crop acreages projected earlier in this report are used to determine the increase in net irrigated crop acreage in the State "required" to meet demand. The second section contains the planned increase in irrigated acreage according to the California Water Plan. Considerable discussion in this section is also devoted to the closely related question of urbanization of agricultural land. Third, a comparison of the irrigated acreages "required" to meet demand and the acreages to be "supplied" by the California Water Plan provides a tentative answer to the question posed at the beginning of this paragraph.

Irrigated Acreage Requirements

Figure 1 provides a convenient overall summary of harvested crop acreages of field crops, permanent crops, and vegetables in California from 1950 to 1968, together with projections (see earlier Table 6) to 1980 and 2000. The total harvested acreage of these crops shows no discernible trend over the 1950-68 period but reveals considerable year-to-year variation. A quick review of this period suggests some of the difficulties and uncertainties in projecting field crop acreages. The increase in field crops to nearly 7.0 million acres in the early 1950's is explained primarily as a buildup in cotton acreage in anticipation of impending allotments; cotton acreage increased from 581,000 acres in 1950 to 1,340,000 acres in 1953. With the imposition of cotton allotments in 1954, roughly 0.5 million acres were shifted from cotton to feed grains--mainly to barley. Feed grain acreage remained high, reaching a peak of over 2.5 million acres in 1957. Since that time, feed

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[1/] The reader is reminded that the levels of demand and acreages "required" are based on the assumption of price levels remaining constant at recent average levels.

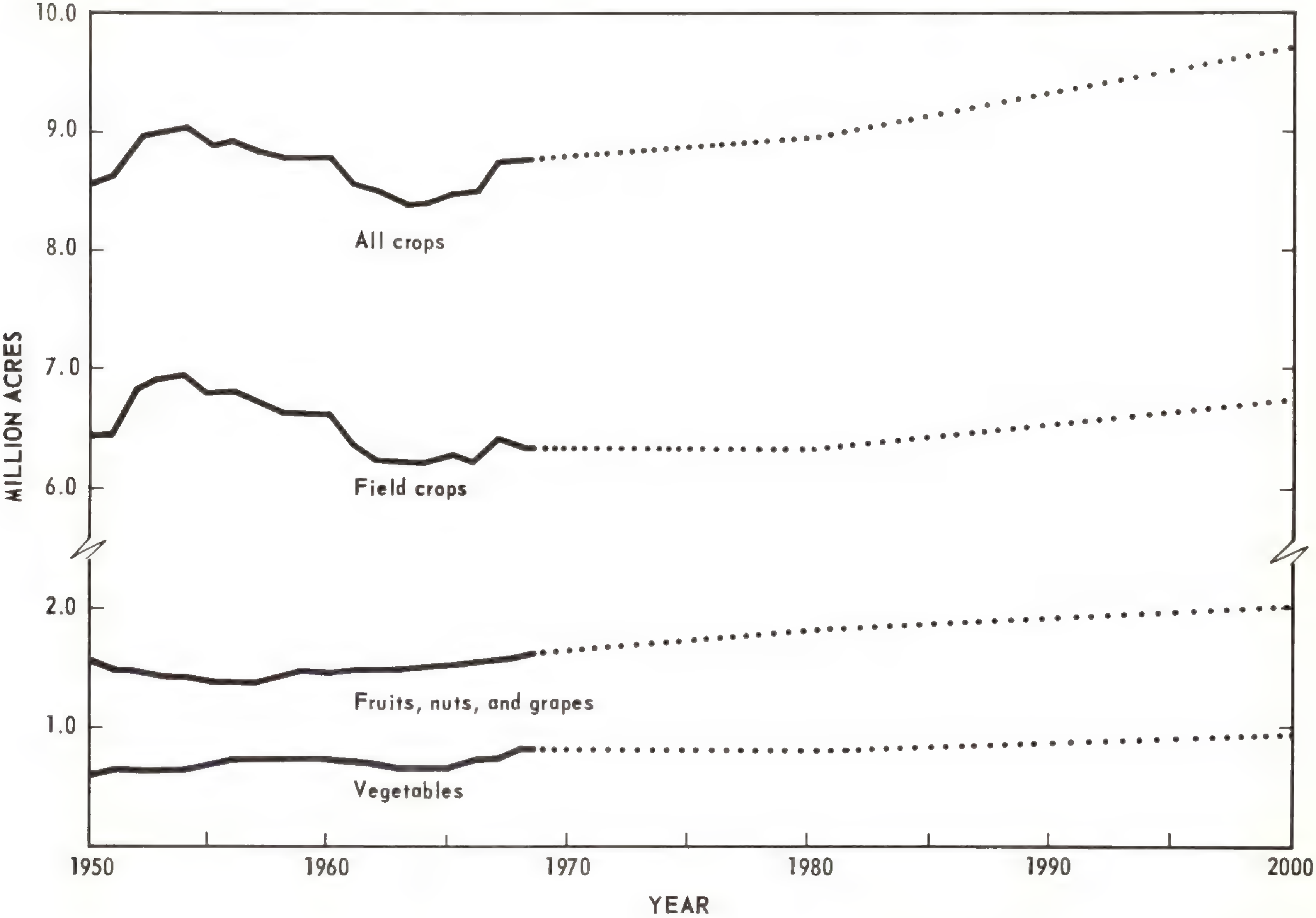

FIGURE 1. Harvested Acreages of All Crops in California, 1950-68, with Projections to 1980 and 2000

grain acreage has dropped by about 0.5 million acres. This decline, along with the long-term downtrend in wheat acreage in the State, explains most of the decline in total field crop acreage from the mid-1950's to the mid-1960's.

Future field crop acreages in California will continue to be influenced strongly by various federal farm programs. Because of the uncertainties of future farm programs, however, the projections shown in Figure 1 have been based on the assumption of no drastic change in government programs. Changes in government programs very likely will occur and implications for crops such as sugar beets, rice, and cotton are discussed in Part II of this report.

The projected future general upward trend in harvested acreages of fruits, nuts, grapes, and vegetables shown in Figure 1 is borne out by actual trends in the past decade. The reasons for these past trends--strong increase in U.S. demand, strong competitive position of California because of climate and established growers, processors, and distributors--are expected to continue in the future.

While the level of aggregate harvested crop acreage has changed little in the State over the 1950-68 period, the percentage of harvested crops grown on irrigated land has increased considerably and is expected to increase. Table 14 shows by crop and crop category the estimated proportions of harvested acreage which are grown on irrigated land. For such crops as sugar beets, rice, cotton, potatoes, vegetables, and irrigated pasture, essentially the entire acreage is irrigated. Through time, higher percentages of the other crops, primarily wheat, feed grains, hay, trees, and vines have also been irrigated. These trends are expected to continue.

Table 15 shows the translation of total acreage harvested in the State into total net irrigated acreage (irrigated acreage planted). The left-hand portion of the table shows harvested acreages for field crops, vegetables, tree fruits, nuts, and grapes. In addition, estimates are provided of irrigated pasture and double-cropping. The figures at the bottom of this portion of the table therefore represent total acreage harvested in the State. The center portion of Table 15 shows the results of converting total acreage harvested to irrigated acreage harvested, using the ratios presented in Table 14. The right-hand portion of Table 15 shows the conversion of irrigated acreage harvested to irrigated acreage planted, using the ratios presented in the last column of Table 14. Planted acreage exceeds harvested acreage due to crop

TABLE 14

Estimated and Projected Ratios of Irrigated Acreage Harvested to Total Harvested Acreage and Ratios of Irrigated Acreage Harvested to Irrigated Acreage Planted in California

Crop	Ratios of harvested irrigated acres to total harvested acres							Ratios of irrigated acreage harvested to irrigated acreage planted c/
	1950	1960 a/	1961-65	1965 b/	1968	1980	2000	
Field Crops								
Sugar beets	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.96
Wheat d/	.19	.22	.28	.30	.31	.36	.40	.90
Rice	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.97
Dry beans	.75	.89	.90	.91	.91	.93	.95	.94
Potatoes	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.94
Safflower	.58	.58	.58	.58	.58	.60	.60	.94
Alfalfa seed	.81	.98	.98	.99	.99	1.00	1.00	.94
Cotton	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.98
Corn	.81	.95	.95	.95	.95	.96	.97	.90
Oats d/	.11	.15	.18	.20	.23	.38	.38	.90
Barley d/	.33	.50	.53	.55	.55	.55	.55	.90
Grain sorghum	.58	.94	.95	.96	.96	.97	.98	.90
Alfalfa hay	.92	.94	.95	.96	.96	.97	.98	.95
Other hay	.26	.46	.50	.54	.57	.68	.75	.90
Misc. field crops	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.94
Total								
Vegetables	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.94
Tree fruits, nuts, and grapes d/	.79	.90	.91	.92	.92	.96	.97	.98
Irrigated pasture	1.00	1.00	1.00	1.00	1.00	1.00	1.00	.98
Double cropped acres	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

a/ From U.S. Bureau of the Census [1961].

b/ From U.S. Bureau of the Census [1967].

c/ From California Department of Water Resources [1969, p. 57].

d/ Projections of percentages to 1980 and 2000, a result of 1980 and 2000 projections of actual acreages.

TABLE 15

Summary of Base Year and Projected Total Acreage Harvested, Total Irrigated Acreage Harvested, and Total Irrigated Acreage Planted in California

Crop	Total acreage harvested							Total irrigated acreage harvested							Total irrigated acreage planted						
	1950	1960	1961-65 average	1965	1968	1980	2000	1950	1960	1961-65 average	1965	1968	1980	2000	1950	1960	1961-65 average	1965	1968	1980	2000
	1,000 acres																				
Field crops																					
Sugar beets	209	207	286	310	254	325	442	209	207	286	310	254	325	442	218	216	298	323	264	338	460
Wheat	651	347	301	278	379	234	208	124	76	84	83	117	84	83	138	84	93	92	130	93	92
Rice	238	288	318	327	432	288	256	238	288	318	327	432	288	256	245	297	328	337	445	297	264
Dry beans	311	221	217	206	214	215	247	233	197	195	187	195	200	235	248	210	207	199	207	213	250
Potatoes	121	103	101	107	92	94	102	121	103	101	107	92	94	102	129	110	107	114	98	100	108
Safflower	10	167	261	284	165	364	348	6	97	151	165	96	218	209	6	103	161	176	102	232	222
Alfalfa seed	115	141	114	110	98	160	226	93	138	112	109	97	160	226	99	147	119	116	103	170	240
Cotton	581	946	765	725	687	838	847	581	946	765	725	687	838	847	593	965	781	740	701	855	864
Corn	42	130	103	144	185	193	186	34	124	98	137	176	185	180	38	138	109	152	196	206	200
Oats	196	155	123	109	85	65	66	22	23	22	22	20	25	25	24	26	24	24	22	28	28
Barley	1,765	1,586	1,447	1,402	1,406	1,266	1,380	582	793	767	771	773	696	759	647	881	852	857	859	773	843
Grain sorghum	114	233	250	316	360	374	393	66	219	238	303	346	363	385	73	243	264	337	384	403	428
Alfalfa hay	1,058	1,192	1,161	1,176	1,152	1,151	1,281	973	1,120	1,103	1,129	1,106	1,116	1,255	1,024	1,179	1,161	1,188	1,164	1,175	1,321
Other hay	855	741	683	679	712	616	647	222	341	342	367	406	419	485	247	379	380	408	451	466	539
Miscellaneous field crops	154	158	150	123	130	150	150	154	158	150	123	130	150	150	164	168	160	131	138	160	160
Total	6,420	6,615	6,282	6,296	6,351	6,332	6,780	3,658	4,830	4,732	4,865	4,927	5,161	5,639	3,893	5,146	5,044	5,194	5,264	5,509	6,019
Vegetables	604	721	693	649	825	833	958	604	721	693	649	825	833	958	643	767	737	690	878	886	1,019
Tree fruits, nuts, and grapes	1,536	1,464	1,485	1,529	1,617	1,817	1,995	1,213	1,318	1,351	1,407	1,488	1,744	1,935	1,238	1,345	1,379	1,436	1,518	1,780	1,974
Irrigated pasture[a]	978	1,179	1,100	1,023	1,025	1,025	1,025	978	1,179	1,100	1,023	1,025	1,025	1,025	998	1,203	1,122	1,044	1,046	1,046	1,046
Double cropped acres[b]	- 330	- 330	- 330	- 330	- 355	- 462	- 504	- 330	- 330	- 330	- 330	- 355	- 462	- 504	- 330	- 330	- 330	- 330	- 355	- 462	- 504
TOTAL	9,208	9,649	9,230	9,167	9,463	9,545	10,254	6,123	7,718	7,546	7,614	7,910	8,301	9,053	6,442	8,131	7,952	8,034	8,351	8,759	9,554

a/ From U.S. Bureau of the Census [1961, 1967].

b/ From California Department of Water Resources [1969, p. 58].

Source: Tables 3, 4, 5, and Table 14.

failure, green manure crops, market conditions, overplanting of allotment acreages, reclamation of salt-affected lands, freezing, labor problems, and related causes.

The total irrigated acreage planted shown in Table 15 increased from about 6.4 million acres in 1950 to 8.1 million acres in 1960. Rather surprisingly, however, Table 15 shows that the irrigated acreage declined slightly between 1960 and 1965. This apparent decline is probably due to statistical deficiencies rather than reflecting an actual decrease in irrigated acreage. Several factors could help explain the statistical decline. First, irrigated pasture declined by about 160,000 acres in that period. These figures are census data for 1959 and 1964 and may be inaccurate as well as not applying exactly to the desired years 1960 and 1965. Second, the total harvested acreage of field crops drops by about 320,000 acres over the 1960-65 period, even though irrigated acreage planted increases by about 50,000 acres. Third, the vegetable acreage in the particular year 1965 was the lowest in the previous decade and also lower than in the years since 1965. Fourth, the conversion factors in Table 14 undoubtedly fluctuate from year to year even though their trends are discernible and fairly predictable over time. Table 15 shows that irrigated acreage planted in 1968 increased to 8,351,000 acres. Thus, the general pattern of increase from 1950-68 is quite reasonable and the data for the particular year 1965 probably underestimate the actual irrigated acreage in that year.

Table 15 shows that irrigated acreage planted is projected to reach 8,759,000 acres in 1980 and 9,554,000 acres in 2000. Compared with 1968, these represent increases in irrigated land "required" to meet demand of about 0.4 million acres to 1980 and about 1.2 million acres to 2000. We turn now to the increases in irrigated acreages projected to be developed by the California Water Plan.

Planned Irrigation Development

There are several available sources of data on current and past land use in California. However, since these data are frequently collected on different bases, in different time periods, and for different purposes, there are a number of apparent inconsistencies that must be reconciled. Given these difficulties, the authors have attempted to compile the available information into an internally consistent overall picture of total land use in the State. Various agencies have also made projections of particular land uses to various dates.

For our purposes, the most critical land use categories are "urban use" and "irrigated crop land." Consistent with the purpose of this section, we will use estimates and projections of urban use and irrigated crop land provided by the California Department of Water Resources (DWR) in their bulletin entitled "Implementation of the California Water Plan" [1966]. The top two sections of Table 16 show the DWR estimates of urban and irrigated land use for 1960 together with their projections to 1980 and 2000 for the eleven hydrologic study areas of California (Figure 2). As will be discussed in more detail below, subsequent studies suggest that the DWR urban land use projections are quite reasonable. The projections of irrigated acreage, while undergoing periodic review and revision, have not been officially revised and are still considered quite reasonable by agency personnel contacted.

While the discussion to follow concentrates primarily on urban and irrigated land uses, the authors have attempted in Table 16 to provide estimates and projections of the remaining land uses in California which would be consistent with the DWR data on the first two use categories. As a basis for the projections of the remaining land uses, the authors have relied primarily on a study by the California Conservation Needs Committee of the Soil Conservation Service [1961] which shows land use by county in 1958 with projections to 1975.[1] The categories of agriculturally related land uses (nonirrigated crop land, pasture and range, and forest and woodland) in Table 16 were projected to 1980 and 2000 by the authors based on the rates of change projected

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[1] Since the hydrologic study areas of Table 16 do not always conform to county lines, the SCS county data were subdivided where necessary into two or more hydrologic regions using (1) a study by the California State-Federal Interagency Group [1968], which gives acreages of each of the 58 counties in the 11 hydrologic regions and (2) maps of the hydrologic regions from the California Department of Water Resources [1966] showing the location of irrigated, irrigable, and urban uses in each county and hydrologic region.

TABLE 16

Estimated Land Use by Hydrologic Area of California in 1960 and Projected for 1980 and 2000

Land use category	Year	Hydrologic study areas of California											
		North Coastal	San Francisco Bay	Central Coastal	South Coastal	Sacramento Basin	Delta-Central Sierra	San Joaquin Basin	Tulare Basin	North Lahontan	South Lahontan	Colorado Desert	State total
		1,000 acres											
Urban	1960	44	443	80	998	178	47	64	149	4	25	36	2,068
	1980	67	820	180	1,550	317	92	101	262	8	107	63	3,568
	2000	94	1,060	309	1,900	443	150	165	412	15	193	100	4,841
Irrigated cropland	1960	258	160	370	476	1,410	708	1,154	2,709	125	89	626	8,085
	1980	290	210	388	381	1,685	756	1,395	3,100	131	81	643	9,060
	2000	334	210	415	321	1,895	807	1,635	3,490	141	64	657	9,970
Nonirrigated cropland	1960	253	313	828	294	1,225	280	369	274	36	87	110	4,069
	1980	242	195	820	115	829	168	249	144	41	82	103	2,988
	2000	232	127	812	49	581	108	174	83	46	78	97	2,387
Pasture and range	1960	740	964	1,541	620	1,827	694	1,464	2,653	728	1,646	618	13,494
	1980	724	855	1,580	310	2,046	595	1,511	2,180	706	1,715	584	12,806
	2000	707	769	1,617	166	2,266	519	1,554	1,821	687	1,782	554	12,442
Forest and woodland total	1960	4,569	1,537	2,269	1,368	5,409	877	1,137	1,286	419	723	849	20,443
	1980	4,517	1,480	2,127	1,100	4,949	756	905	1,256	423	716	764	18,993
	2000	4,469	1,428	2,007	900	4,530	660	730	1,230	426	709	693	17,782
(Forest and woodland with grazing)	1960	(1,551)	(587)	(933)	(252)	(2,813)	(466)	(642)	(955)	(214)	(352)	(194)	(8,959)
	1980	(1,556)	(591)	(979)	(336)	(2,404)	(368)	(529)	(973)	(221)	(361)	(287)	(8,605)
	2000	(1,561)	(595)	(1,023)	(438)	(2,090)	(298)	(443)	(990)	(227)	(370)	(410)	(8,445)
Other uses	1960	5,400	239	2,227	3,230	6,665	503	2,828	4,006	2,332	14,694	9,925	52,048
	1980	5,426	96	2,220	3,529	6,888	742	2,856	4,134	2,334	14,562	10,007	52,793
	2000	5,428	62	2,155	3,649	6,999	865	2,759	4,040	2,328	14,437	10,063	52,785
TOTAL	All years	11,265	3,656	7,315	6,985	16,714	3,109	7,017	11,076	3,643	17,263	12,164	100,207

Sources: 1960 data on urban land and irrigated crop land from California Department of Water Resources [1966]; 1960 data on the other land use categories assumed equal to those in 1959 from California Conservation Needs Committee [1961]; 1980 and 2000 projections by authors. See text for methods.

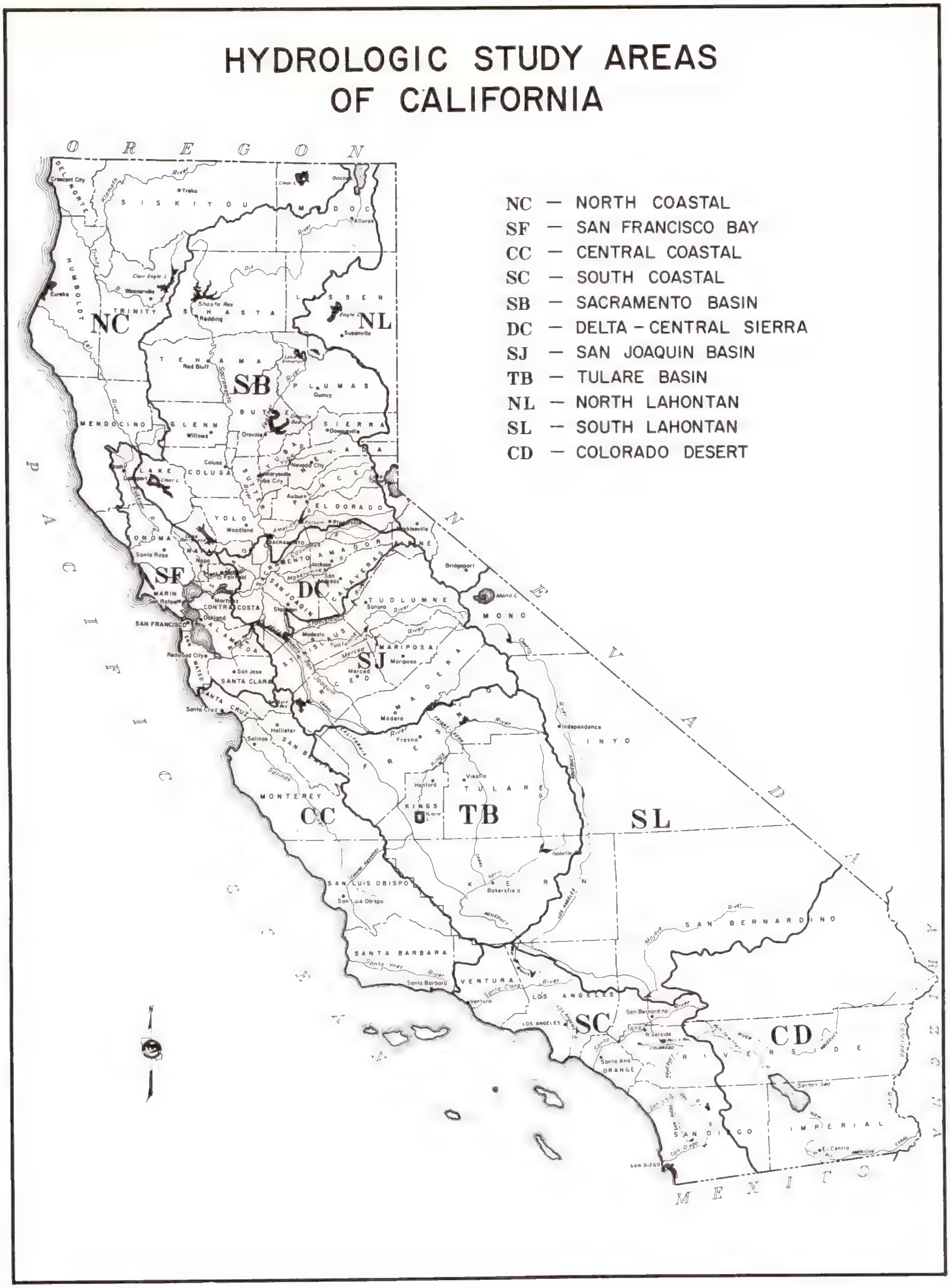

FIGURE 2. Hydrologic Study Areas of California

Source: California Department of Water Resources.

between 1958 and 1975 by the SCS Needs study [1961].[1] The final category of "other uses" in Table 16 is a residual figure made up principally of federal land but including water areas, farmsteads, idle land, and wildlife areas.

The substantial increases in urban acreage and irrigated crop land in Table 16 imply, of course, corresponding decreases elsewhere. Although quantification of the precise shifts between all pairs of categories is not possible, the major shifts are as follows: (1) from crop land, pasture, and range to urban uses; (2) from nonirrigated to irrigated crop land; (3) from pasture and range to crop land; and (4) from forest and woodland to pasture and range.[2] Table 16 shows that these shifts are projected to take place with little change in the "other use" category. The following two subsections examine in more detail the expected shifts of land to urban use and the planned increases in irrigated acreage under the California Water Plan.

Urban Land Use Projections

Several studies related to the rate of urbanization of land in California are available. They differ in definitions used, methods of measurement, and

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[1] More specifically, if a particular acreage category was projected to decline over time, the acreage (A) in any year (t) is related to the previous year by the formula,

$$A_t = \frac{A_{t-1}}{1+r},$$

where r is the rate of change. To find the annual rate of change, the following equation was solved for r, based on SCS acreage (A) in 1958 and 1975.

$$A_{1975} = \frac{A_{1958}}{(1+r)^{17}}.$$

This rate was then applied to each of the relevant categories to obtain estimates for 1980 and 2000. This formulation projects a declining absolute change over time. However, an alternative set of estimates based on constant absolute changes over time showed only moderately greater changes to the year 2000.

[2] The SCS Needs study [1961] summarizes expected shifts from 1958 to 1975 among categories. An updating SCS Needs study now being done, together with the earlier study, should give a good picture of the actual shifts between 1958 and 1967.

methods of projections. A recent study by Shumway [1970] estimates 2,031,000 acres in urban use in California in 1964 with a projection of 2,971,000 acres in 1980. The Shumway study is based on an extension to the entire State of a study of 25 urban counties by Ruth and Krushkhov [1966]. The California DWR estimates 2,068,000 acres of urban land in 1960, with a 1980 projection of 3,568,000 (see Table 16). Thus, although the base figures in the two studies are similar, the rate of urbanization projected by DWR is higher. The rate of urbanization implied by Shumway's projections is about 60,000 acres per year compared to about 75,000 acres per year for DWR.

A recent study by the Economic Research Service of the U.S. Department of Agriculture [1970] provides another check on these estimates. Based on air photos of California and other states over approximately 10-year intervals ending in 1959-65, the USDA study estimates an average relationship of 0.07 acres per capita as a general guide for urban land use planning in large heterogeneous areas. Based on a California population increase of 537,000 people per year between 1965 and 1980 (California Department of Finance, [1968]), the urban land requirement (at 0.07 acres per capita) would be only about 40,000 acres per year. The USDA study showed that an average of 0.13 acres of land was urbanized per capita in counties falling outside the more heavily urbanized counties. Even if this higher rate is applied to all of California, it would give an annual land urbanization rate in California of only about 70,000 acres per year. Further, the USDA study [1970, p. 7] states, however: "As an area becomes more populous and takes on metropolitan characteristics, land is used more intensively and less additional surface area is taken for work, living, and service functions for each new person added to the population." This statement would appear to apply well to future urban development in California.

Although there is no clear choice among the alternative urban estimates available, it appears that the California DWR projections shown in Table 16 are reasonable. Compared with Shumway [1970] and the USDA study [1970], they appear slightly high. It should be pointed out, however, that the SCS Needs study [1961] and subsequent studies using the same methods come up with higher acreages already urbanized (e.g., 2,392,000 acres in 1958) and considerably higher annual rates of urbanization (as high as 135,000 to 150,000 acres per year). While the SCS studies are very useful in tracing shifts in land use, particularly by land quality, it appears to the authors that the definitions and methods used considerably overestimate urbanization rates.[1]

The preliminary results of an updated SCS Needs study, however, provide some interesting information on projected shifts according to land quality between 1967 and 1980. Of the land projected to shift to urban uses in California over the 1967-80 period, about 27 percent is prime agricultural land (defined here as SCS land capability classes I and II), 37 percent is land with lower agricultural capabilities (SCS classes III and IV), and the remaining 36 percent is land not suited for cultivation (SCS classes V through VIII). The major projected shifts to urban use are near existing urban areas; leading counties are Los Angeles, Sacramento, San Diego, and Fresno. The Bay Area urban expansion is large but spread over several surrounding counties. Other counties with large projected shifts are Shasta, Orange, Kern, Tuolumne, and San Bernardino. In the counties of Los Angeles, Fresno, Kern, and Shasta, roughly half of the land converted to urban uses is prime agricultural land (SCS classes I and II). In Sacramento, Orange, San Diego, Tuolumne, and San Bernardino, the percentage of prime land converted to urban use is quite small. At least a partial offset against these losses is newly reclaimed irrigated land which, after leaching and development, should move up within the land capability classes.

Features of the California Water Plan[2]

Studies leading to the California Water Plan demonstrated that the State has sufficient water resources within its boundaries to meet projected urban and agricultural water requirements of 38 million acre-feet in the year 2020. The major objective of the California Water Plan is to develop water resources in areas of excess supply--mainly the northern part of the State--and export water to the deficit areas in the southern part of the State.

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[1] Perhaps the updated SCS Needs study soon to be published will help to clarify the differences between their estimates of conversion for nonagricultural use and the urban estimates of other studies and to provide a better idea of the land classes and uses from which urban acreage will come.

[2] The information in this section is based on a study by the California Department of Water Resources [1966].

The projected net water requirements in the State by hydrologic regions are shown in Figure 3 (California Department of Water Resources, [1966]). Table 17 summarizes water requirements on both an applied and net basis, as well as showing the breakdown between agricultural and urban water use. Urban use is projected to expand from about 10 percent of applied water requirements in 1960 to around 20 percent by 1980 and 28 percent by 2020. The projected increase in urban water use is greater than that for agriculture, even measured in absolute terms. Still, Table 17 shows clearly that agriculture is and will remain by far the State's major user of water.

Figure 4 shows the general sources from which total water requirements are planned to be met. The key role of the Central Valley Project and the State Water Project is evident. In 1960, the Central Valley Project provided for about 23 percent of California's total net water requirements; by 1990 the Central Valley and State Water Projects are projected to account for about 50 percent of the total.

Figure 5 illustrates the projected timing and additional water yield capability of future projects within the Central Valley Project-State Water Project system. The downward sloping lines starting in 1970 show the combined dependable water supply capability of existing and authorized features of the system. The upward sloping line starting in 1970 depicts the combined projected net water requirements to be met by these projects as projected by DWR. (This line is the same as the bottom line in preceding Figure 4.) The graph indicates a need for additional water conservation facilities in the late 1980's. The most likely projects are planned for the North Coast--the upper Eel River, the lower Trinity River, and the Mad and Van Duzen rivers. However, these projects are currently under considerable debate, which could result in significant alteration in plans. In a more general context, land use planners are devoting increasing attention to such basic questions as optimum location and density of urban centers. The outcome of these deliberations may well influence, e.g., through zoning and tax policy, the location and size of blocks of land allocated for agricultural and nonagricultural uses. An important related question in regional and metropolitan planning is whether planners should encourage the movement of resources, such as water, to current metropolitan centers or encourage people to locate in areas where such resources are more readily available in terms of their physical and economic supply. Any land use projections thus are subject to changes in the attitude

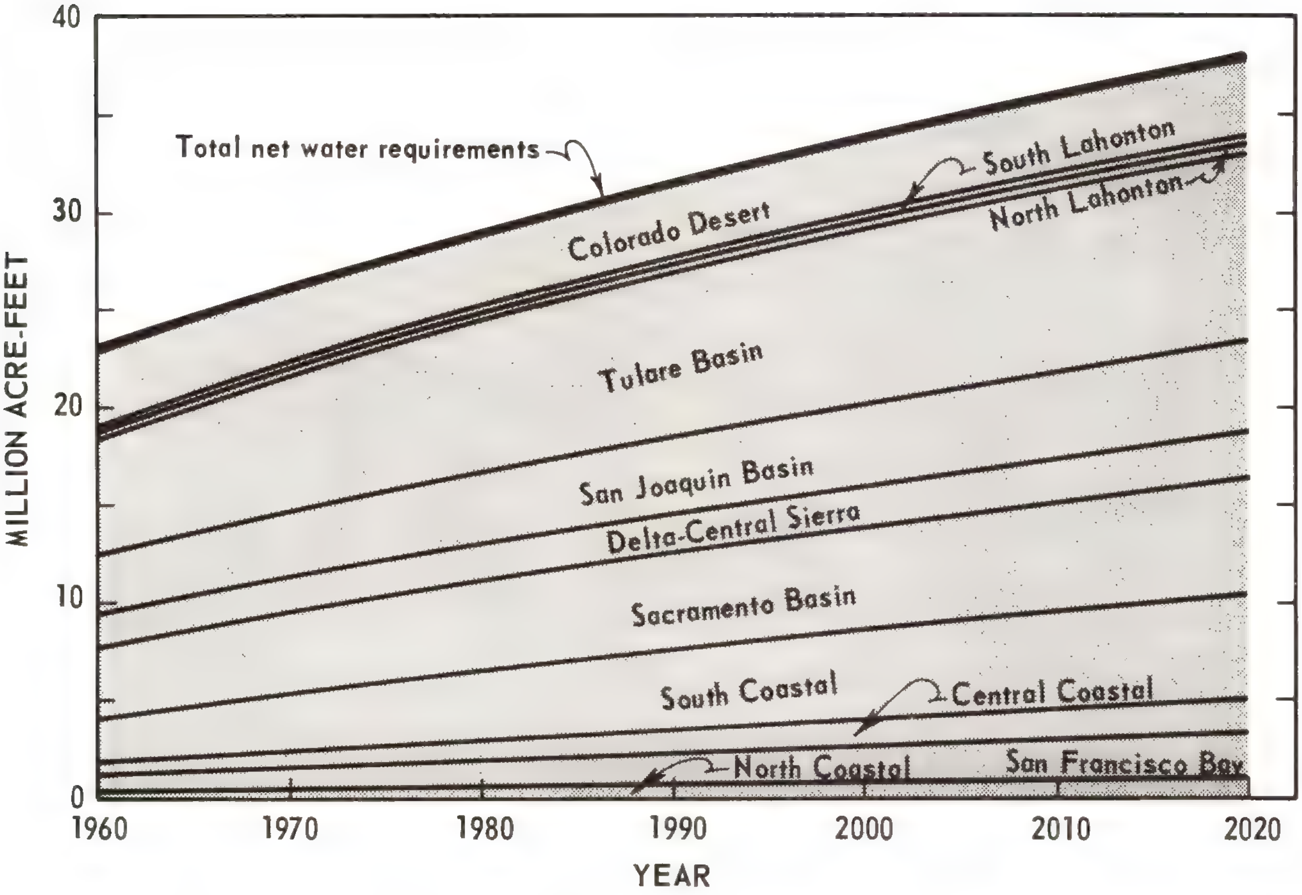

FIGURE 3. Net Water Requirements--Statewide Totals

Source: California Department of Water Resources [1966].

TABLE 17

Summary of 1960 and Projected Water Requirements on Hydrologic Study Areas

Items	North Coastal	San Francisco Bay	Central Coastal	South Coastal	Sacramento Basin	Delta-Central Sierra	San Joaquin Basin	Tulare Basin	North Lahontan	South Lahontan	Colorado Desert	State totals
	1,000 acre-feet											
Applied water requirements												
Agricultural												
1960	420	330	660	1,080	5,900	2,960	4,620	7,600	400	409	4,103	28,482
1990	650	440	780	860	6,910	3,080	5,460	9,400	420	360	3,960	32,320
2020	930	280	950	760	7,950	3,280	6,020	10,900	500	175	3,960	35,705
Urban												
1960	20	590	110	1,640	250	100	130	300	10	46	61	3,257
1990	170	1,480	360	3,950	740	290	270	730	20	320	150	8,480
2020	320	2,120	780	5,560	1,490	590	600	1,600	30	600	310	14,000
Totals												
1960	440	920	770	2,720	6,150	3,060	4,750	7,900	410	455	4,164	31,739
1990	820	1,920	1,140	4,810	7,650	3,370	5,730	10,130	440	680	4,110	40,800
2020	1,250	2,400	1,730	6,320	9,440	3,870	6,620	12,500	530	775	4,270	49,705
Net water requirements[a]												
1960	350	860	670	2,180	3,630	1,810	3,060	5,930	200	255	4,161	23,106
1990	660	1,820	920	4,070	4,800	2,110	3,920	8,570	270	295	4,035	31,470
2020	1,000	2,260	1,580	5,730	5,780	2,370	4,570	9,840	370	320	4,180	38,000

a/ Applied water requirements less estimated quantities available for reuse.

Source: California Department of Water Resources [1966].

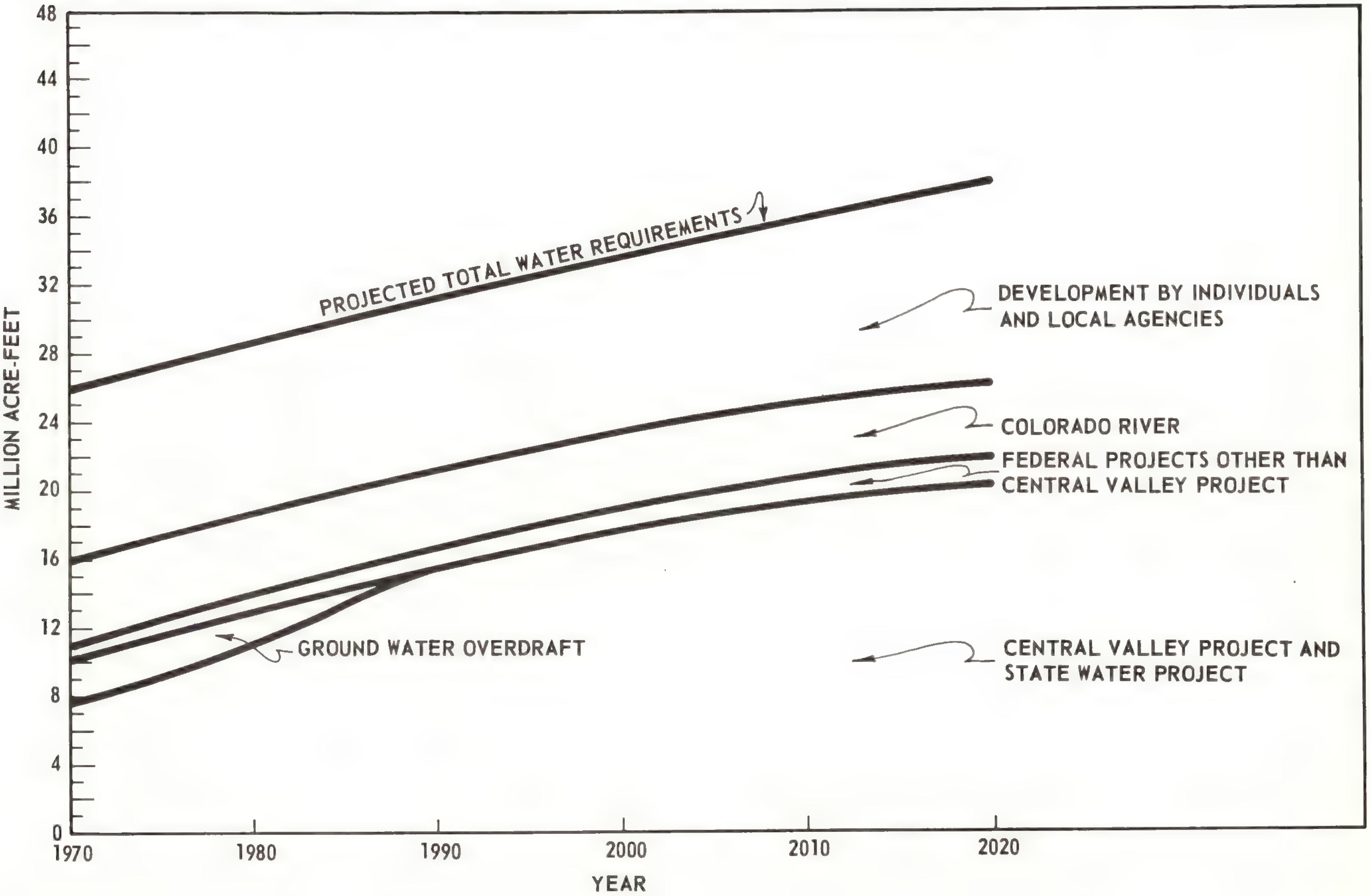

FIGURE 4. Sources of Water Supply to Meet California's Projected Water Requirements

Source: California Department of Water Resources [1966].

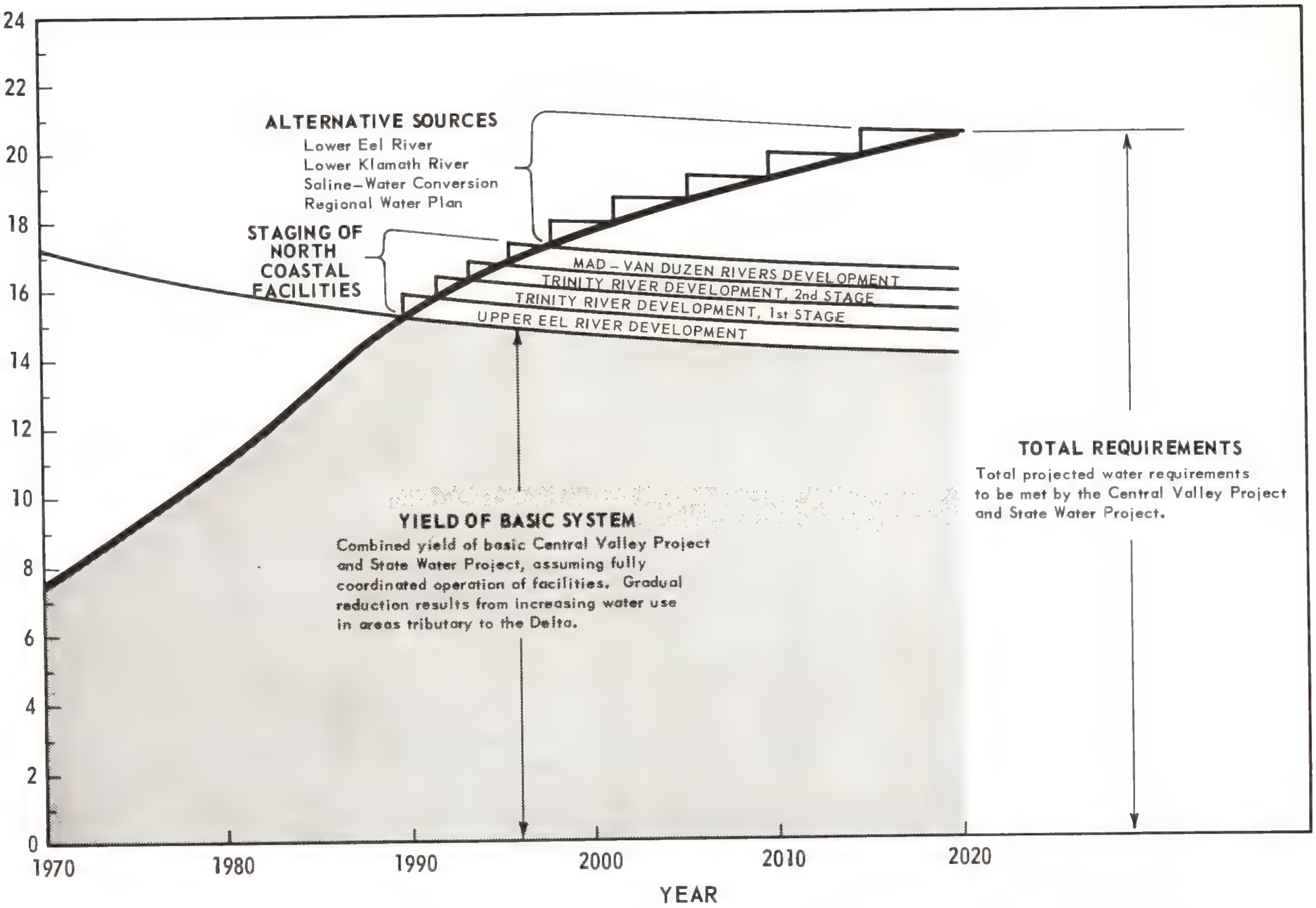

FIGURE 5. Staging of Major Conservation Facilities to Meet Projected Water Requirements of the State Water Project and Central Valley Project

Source: California Department of Water Resources [1966].

of people as to a desirable environment for living and working and as to the location of industry, including agriculture. More detailed indications of sources of water supply and export in relation to water requirements are available from a publication of the California Department of Water Resources [1966].

Consistent with this picture of planned water development are the DWR estimates of irrigated crop land shown earlier in Table 16. That is, according to the California Water Plan, irrigated crop land acreage is projected to increase by about 1.0 million acres between 1960 and 1980 and by nearly another 1.0 million acres by 2000. Practically all of this increase is in the Central Valley (the Tulare Basin, San Joaquin Basin, and the Sacramento Basin) as a result of expected irrigation development projects.

Comparisons of Irrigated Acreage "Required" and Planned Rates of Irrigation Development

The preceding data allow a comparison between the irrigated acreage "required" to meet demand at constant prices and the rate of irrigation development planned by federal and State water agencies in California. Two such comparisons are shown in Table 18. The top row shows the projected irrigated acreage "required" from earlier Table 16.[1] The second row provides the estimate of acreage to be developed by the California Water Plan. While the 1960 data in the two rows are not identical because of slight differences in definitions, data sources, etc., the acreages are of a similar order of magnitude--about 8.1 million acres. In 1980, the estimates of acreage "supplied" exceed acreage "required" by about 0.3 million acres; in 2000 the difference increases to about 0.4 million acres.

The third line of Table 18 shows the projected aggregate net irrigated acreage from a more recent DWR study of market outlook for California crops [1969]. Again the 1965 acreages are similar to those in the present study. However, DWR estimates in 1980 and 2000 exceed those of this study by about 0.8 million acres and 0.6 million acreages, respectively.

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[1] The term "irrigated acreage planted" in Table 16 appears comparable with the term "net irrigated land" used by the California Department of Water Resources. Neither estimate includes the "associated noncropped area" (farmsteads, fallow, roads, ditches, rights-of-way, fences, turn areas, etc.) which, when added to net irrigated acreage, determines gross land area (irrigable land required).

TABLE 18

Comparisons of Irrigated Acreage Projections

Source	Definition	Year 1960	1965	1980	2000
		1,000 acres			
Dean, *et al.*, [1970]	Irrigated acreage planted	8,131	8,034	8,759	9,554
DWR [1966, Table 4]	Net irrigated land	8,085	--	9,060[a]	9,970[a]
DWR [1969, Tables 15, 18][b]	Net irrigated land	--	8,148	9,584	10,154

a/ Interpolated from data for 1960, 1990, and 2020.

b/ Data adjusted by authors to refer to the state of California rather than to the California Region, which includes portions of Oregon.

The major differences in acreage projections between the present study and the latter DWR study [1969] can be summarized briefly as follows: The DWR study projects considerably higher acreages of rice and alfalfa hay and somewhat higher acreages of cotton and sugar beets. It also projects larger increases in the general category of miscellaneous hay, grain, and pasture. The aggregate acreage of specialty crops--tree fruits, nuts, grapes, and vegetables--is quite similar. It is well recognized that field crop acreage is the most difficult to project because of the uncertain impact of government programs and, in the case of all grains except rice, the extremely small percentage of U.S. production grown in California.

However, there are reasons to suggest that even our projections of field crop acreage may be high. A particularly critical commodity is cotton, since it is the dominant stable high income crop in most parts of the San Joaquin Valley. The State cotton acreage projection earlier in this report was based on the demand for U.S. cotton reported by Daly and Egbert [1966b]. Since that time, the competitive position of cotton has continued to decline in relation to competitive fibers in all end-use markets. Based on more recent trends in the cotton industry, the authors (p. 120) provide an alternative estimate showing cotton in California declining from 765,000 acres in 1961-65 to 748,000 acres in 1980 rather than increasing to 838,000 acres as projected earlier (Table 3). The lower acreage figure for cotton is also more in line with experience since 1961-65. Should the government program for cotton be altered, it seems most likely to be in a direction of lower average prices, payment limitations, and relaxation of acreage allotments. Also, some cotton producing areas of the State are experiencing difficulty in maintaining yields as a result of insect and disease problems. Because of these uncertainties and difficulties it is quite possible that many California cotton growers will be searching for high value crops to replace cotton in their cropping systems in the immediate future.

Another key field crop in California affected by federal farm programs is rice. The future for rice is highly dependent on the international situation, which could change markedly. However, the development and probable spread of new high yielding rice and wheat varieties in other parts of the world and the possible end of the war in the Far East suggest the possibility of a decline in U.S. exports of rice from earlier 1961-65 levels.

The future position of feed grains (including Mexican wheat) in California's agricultural economy is important in the overall State crop acreage projections. As discussed earlier, California is now and will almost certainly continue to be strongly deficit in feed grain production. Feed grain prices in California are therefore determined primarily by Midwest and Great Plains prices plus transportation costs to California. Thus, feed grain prices will be affected little by changes in the California livestock industry or by change in feed grain acreage in the State. Thus, the question is primarily whether feed grains will give sufficiently high returns to find an expanding role in California cropping systems. Given high land and water costs, it is doubtful that there is much economic incentive for expansion in feed grain acreage. Other large acreages in the field crop category are alfalfa hay and other hay. Alfalfa hay acreage will be determined primarily by the size of the State's livestock industries, particularly the dairy industry. However, beef cattle also require substantial quantities of alfalfa and other hay as well as irrigated pasture. The earlier discussion of the uncertainties of the beef cattle feeding industry suggests that the alfalfa and other hay acreages are a large and somewhat sensitive component of the total projected field crop acreage. In summary, study of individual field crops suggests that actual acreages planted are likely to be lower than the "requirements" projected in this report.

Substantial acreages of newly irrigated lands are being developed on the west side of the San Joaquin Valley as indicated earlier.1/ The portions of this land served by State water face extremely high water costs. Extensive production of feed grains and most other field crops under these conditions is of questionable economic feasibility except as interim reclamation "get acquainted" crops. At current price-cost levels, the land is more likely to be developed for trees, grapes, and vegetables which offer a higher payment capacity for water. In addition, if government programs and/or competition from synthetics result in smaller acreages of cotton, many cotton growers in existing areas will also be searching for high value crops to replace cotton

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1/ Development of the west side acreage and its possible impact on specialty crop prices is discussed in more detail in Part II of this report.

in their cropping systems. The result of these forces could be extensive additional plantings of tree nuts, oranges, grapes, and other permanent crops, as well as expansion in vegetable acreages. Consequent price declines could lead to lower land prices, difficulties in repayment for water in newly developed areas, demands for additional or stronger marketing orders or controls, and lower incomes for growers in existing areas.

Of course, a number of factors could alter the planned schedule of water development set forth in the California Water Plan. Resistance to water export by Northern California counties, continued work on sea water desalination, public reaction to pollution of the San Francisco Bay and San Joaquin-Sacramento Delta area, rising problems of drainage water disposal and salinity in the San Joaquin Valley and Imperial Valley, and other factors could alter these plans substantially in the years ahead.

Still, the general conclusion seems inescapable: There is a danger of overdevelopment of irrigated acreage in California for the next decade or longer in that specialty crop prices are likely to be depressed. The rate of loss of agricultural land to urbanization should be no higher than estimated by DWR and may be less. It would appear prudent, therefore, for water planners to reexamine carefully the prospective agricultural demand for water in California and pace water developments accordingly. Part II of this report examines this point in more detail with particular reference to the large-scale development now under way on the west side of the San Joaquin Valley.

PART II

POTENTIAL IMPACT OF SAN JOAQUIN VALLEY WEST SIDE DEVELOPMENT

INTRODUCTION

Part II of this report is divided into three major sections. The first deals with the potential supply or production of those crops which are expected to be important on the west side of the San Joaquin Valley. The second section analyzes past and current trends bearing on the market demand and prices for each of the main crop categories and includes an estimation of price elasticities of demand for the relevant commodities. The third section combines the supply projections with the demand projections and elasticities to estimate plausible price effects for the specified commodities. Although there are uncertainties surrounding these projections, the authors have assembled the best available data and have attempted to trace the price impacts in a systematic way. Perhaps the tentative results presented here will lead to more intensive studies of particular markets.

POTENTIAL PRODUCTION OF SPECIALTY CROPS, INCLUDING WEST SIDE ACREAGE

Definition and Description of the West Side Area

The west side of the San Joaquin Valley is a loosely defined area generally characterized by large corporate farms, mechanized cotton production, and oil fields that extends some 175 miles from San Luis Dam near Los Banos to the Tehachapi Mountains south of Bakersfield. It has an average width of 25 miles along the western side of the Valley floor. Geologically, the area consists of a group of coalescing alluvial fans built up from deposits washed out of the coastal ranges to the west. It is bounded by the coastal ranges to the west, by the Sacramento-San Joaquin Delta to the north, by the trough of the San Joaquin Valley to the east (roughly the San Joaquin River or Fresno slough), and by the Tehachapi Mountains south of Bakersfield. Sparsely populated and arid, the region is mainly irrigated by deep wells which are steadily exhausting the groundwater resources. As thus defined, the west side includes approximately one and one-half million acres.

However, for purposes of this report, the region is defined as San Joaquin Valley land that will be served by water from the California Aqueduct. Thus, the area is defined as the land included in the 13 irrigation districts on the west side which now receive, or plan to receive, State or federal water from the California Aqueduct (see Figure 6).

Table 19 summarizes recent and projected irrigated acres in the 13 districts involved. (Table 19 is, in turn, based on the more extensive Tables A-1 through A-13 in the Appendix.) Irrigated acreage is planned to increase from about 864,000 acres in 1968 to 1,156,000 acres in 1980 and 1,194,000 acres in 1990--increases of about 292,000 acres by 1980 and 330,000 acres by 1990. The major increases in irrigated acreage will be on the west side of Fresno and Kings counties (Westlands Water District) and in the Kern County districts (primarily the Lost Hills, Berrenda Mesa, and Belridge districts on

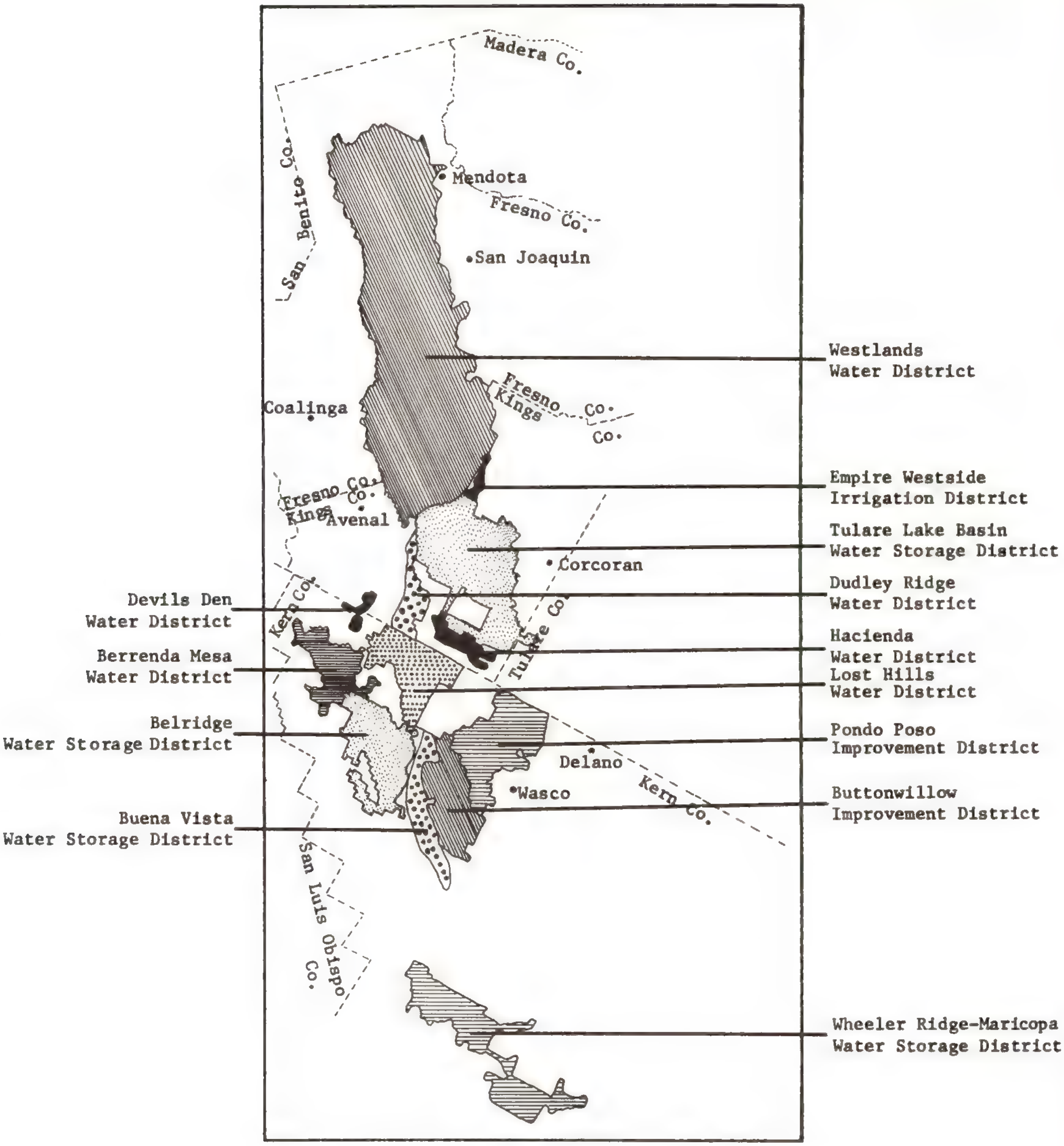

FIGURE 6. Irrigation Districts Included in Westside Study

TABLE 19

Potential Effects of the California Aqueduct on Irrigated Acreage on the San Joaquin Valley West Side

Irrigation District	Irrigated Acres			Added irrigated acres		Acres capable of receiving 3 acre-feet of water, all sources			Added acres capable of receiving 3 acre-feet of water	
	1968[a]	1980	1990	1968-80	1968-90	1968	1980	1990	1968-80	1968-90
	acres									
Westlands Water District	427,000	521,000	521,000	94,000	94,000	331,000	521,000	521,000	190,000	190,000
Empire Westside Irrigation District	6,820	6,820	6,820	0	0	6,000	6,000	5,330	0	-670
Tulare Lake Basin Water Storage District	153,000	166,000	166,000	13,000	13,000	116,000	126,000	122,000	10,000	6,000
Dudley Ridge Water District	10,955	27,540	27,540	16,585	16,585	8,670	19,330	19,330	10,660	10,660
Hacienda Water District	13,920	7,850	7,850	-6,070	-6,070	4,000	9,000	8,670	5,000	4,670
Devil's Den Water District	2,900	6,470	6,470	3,570	3,570	2,670	6,330	5,670	3,660	3,000
Lost Hills Water District	12,000	41,000	54,000	29,000	42,000	10,000	36,000	47,000	26,000	37,000
Berrenda Mesa Water District	20,000	50,000	50,000	30,000	30,000	23,300	62,000	62,000	38,700	38,700
Belridge Water Storage District	12,000	60,000	74,000	48,000	62,000	8,330	41,000	54,000	32,670	45,670
Buttonwillow Improvement District	41,000	47,000	54,000	6,000	13,000	41,000	60,000	60,000	19,000	19,000
Pond-Poso Improvement District	43,000	49,000	53,000	6,000	10,000	49,000	57,670	57,670	8,670	8,670
Buena Vista Water Storage District	59,000	59,000	59,000	0	0	58,000	77,000	83,670	19,000	25,670
Wheeler Ridge-Maricopa Water Storage District	62,000	114,000	114,000	52,000	52,000	58,330	120,670	123,330	62,340	65,000
TOTAL, All Districts	863,595	1,155,680	1,193,680	292,085	330,085	716,300	1,142,000	1,169,670	425,700	453,370

[a] For some districts acreage is for latest year available rather than 1968. See Appendix Tables A-1 through A-13 for details.

Source: Appendix Tables A-1 through A-13.

the west side and the Wheeler Ridge-Maricopa Water Storage District at the southern end of the San Joaquin Valley). These two major areas differ in several important respects. First, Westlands Water District will be served exclusively by federal water at a relatively low price; the Kern County districts receive State water at extremely high prices. Second, much of Westlands Water District is already developed from expensive underground water supplies, such that the federal water will supplement or substitute for groundwater (see Table A-1 for details); the Kern County districts, on the other hand, are new districts receiving water for the first time and are developing large areas of new land. According to Table 19, Westlands Water District will develop an additional 94,000 acres of land by 1990 while the four Kern County districts mentioned will develop an additional 186,000 acres. Thus together the two regions account for 280,000 acres of the 330,000 acres of new land to be developed.

The figures on newly irrigated land above, however, underestimate the total impact of the new water supply. As pointed out above, the new water supplements or replaces groundwater supplies in several districts. One method of roughly assessing the total increase in effective irrigated acreage caused by the additional water supply is to compare the acreage capable of receiving three acre-feet of water in 1968 with that in 1980 and 1990. A supply of three acre-feet of water per acre is approximately sufficient to allow an intensive cropping pattern including summer crops. Table 19 shows that the acreage capable of being intensively cropped could increase by about 426,000 acres between 1968 and 1980 and by about 454,000 acres between 1968 and 1990. By far the largest single area involved is Westlands Water District with 190,000 acres. However, to make this water supply fully effective would require some minor reallocations among districts. These calculations of additional intensively cropped acreage take into account all sources of water supply--State and federal surface sources, other surface sources, and groundwater. (For further details, see Tables A-1 through A-13.)

Projected Cropping Patterns in the West Side Districts

There is considerable interest, as well as some concern expressed by growers in other parts of the State, in the type of cropping pattern which will develop on the west side. It is clear that water costs, particularly in the areas served by State water, will be extremely high. The economic and/or financial feasibility studies prepared for the various districts show that only the higher valued crops--fruits, nuts, grapes, vegetables, and certain field crops such as cotton and alfalfa seed--have the "capacity to pay" the high water charges. Therefore, the projected crop acreages for many of the districts are dominated by such crops. It is extremely difficult to forecast with any accuracy to what extent the actual crop acreages will follow the District projections. However, the District projections would appear to be the logical starting points in trying to forecast actual acreages and supplies from the west side. Table 20, therefore, summarizes the additional acreages of (1) fruits, nuts, and grapes; (2) vegetables; and (3) the specialized relatively high value field crops--alfalfa seed, sugar beets, and cotton--which were projected by detailed feasibility studies for each district.

Table 20 shows that between 1968 and 1980 the District plans call for the following additional acreages: 65,000 acres of fruits, nuts, and grapes; 108,000 acres of vegetables; 36,000 acres of alfalfa seed; 28,000 acres of sugar beets; and 51,000 acres of cotton. From the standpoint of soils and water supply, these projections appear quite plausible. Table 20 indicates that there are about 100,000 acres of additional land in the class A category (see Table A-14 for definitions of soil classes) well suited to deep rooted, sensitive tree crops without a reclamation period; thus, the 65,000 acres projected for these crops appear possible. In addition, there are about 125,000 acres of B soil (suitable for all crops but those very sensitive to salt and boron and capable of being corrected to A soil within about three years) which could be used for vegetables--a large portion of which are double-cropped so that the required net acreage is less than 108,000 acres--or for other sensitive crops.

A similar picture emerges for the period, 1968-1990, with an added 286,000 acres projected of fruits, nuts, grapes, and vegetables; 60,000 acres of alfalfa seed; 47,000 acres of sugar beets; and 86,000 acres of cotton. Again, Table 20 suggests that the quality and quantity of soils and water appear adequate for these projections. Somewhat different sets of west side projections for 1980 and 1990 are presented in a later section that compares specialty crop acreage projections with acreage "requirements."

TABLE 20

Projected Changes in West Side Conditions, Current (Approximately 1968) to 1980 and to 1990

Item	Change from	Unit	Westlands Water District	Empire Westside Irrigation District	Tulare Lake Basin Water Storage District	Dudley Ridge Water District	Hacienda Water District	Devil's Den Water District	Lost Hills Water District	Berrenda Mesa Water District	Belridge Water Storage District	Buttonwillow Improvement District	Pond-Poso Improvement District	Buena Vista Water Storage District	Wheeler Ridge-Maricopa Water Storage District	Total West Side
Added agricultural water supply	1968-80	acre-feet	567,000	0	30,000	32,000	15,000	11,000	76,000	116,000	98,000	57,000	26,000	57,000	187,000	1,272,000
	1968-90	acre-feet	567,000	-2,000	17,000	32,000	14,000	9,000	110,000	116,000	138,000	57,000	26,000	77,000	195,000	1,356,000
Added irrigated acres, class A soils	1968-80	acres	33,000	0	0	2,490	0	3,390	12,200	18,000	30,000	1,000	0	0	N/A	100,080[a]
	1968-90	acres	33,000	0	0	2,490	0	3,390	17,200	18,000	39,000	2,000	1,000	0	N/A	116,080[a]
Added irrigated acres, class A and B soils	1968-80	acres	70,000	0	1,000	12,105	-2,620	3,390	15,640	26,000	47,000	3,000	3,000	0	44,000	225,515
	1968-90	acres	70,000	0	1,000	12,105	-2,620	3,390	22,640	26,000	61,000	7,000	6,000	0	44,000	250,515
Added land capable of receiving 3 acre-feet of water	1968-80	acres	190,000	0	10,000	10,660	5,000	3,660	26,000	38,700	32,670	19,000	8,670	19,000	62,340	425,700
	1968-90	acres	190,000	- 670	6,000	10,660	4,670	3,000	37,000	38,700	45,670	19,000	8,670	25,670	65,000	453,370
Added acreage of fruits, nuts, grapes	1968-80	acres	29,675	0	0	1,270	- 44	390	4,070	14,505	5,380	88	30	0	9,711	65,075
	1968-90	acres	48,240	0	0	2,100	- 44	650	6,782	24,168	8,970	144	45	0	16,201	107,256
Added acreage of vegetables	1968-80	acres	40,331	0	960	1,360	- 30	660	12,820	15,580	9,010	302	150	0	26,915	108,058
	1968-90	acres	67,331	0	1,600	2,270	- 30	1,100	21,361	25,913	15,010	512	250	0	43,175	178,492
Added acreage of high value crops (fruits, nuts, grapes, vegetables)	1968-80	acres	70,006	0	960	2,630	- 74	1,050	16,890	30,085	14,390	390	180	0	36,626	173,133
	1968-90	acres	115,571	0	1,600	4,370	- 74	1,750	28,143	50,081	23,980	656	295	0	59,376	285,748
Added acreage of particular field crops																
Alfalfa seed	1968-80	acres	33,817	0	-4,420	2,280	360	450	- 940	-1,632	4,650	72	45	0	1,067	35,749
	1968-90	acres	56,817	0	-7,360	3,800	600	750	-1,560	-2,720	7,750	127	75	0	1,787	60,066
Sugar Beets	1968-80	acres	19,893	0	0	833	- 60	300	3,770	310	500	800	525	0	649	27,520
	1968-90	acres	32,893	0	0	1,383	- 100	500	7,211	513	840	1,340	875	0	1,089	46,544
Cotton	1968-80	acres	12,536	0	10,820	900	810	- 90	4,600	-2,169	12,550	5,381	2,375	0	3,702	51,415
	1968-90	acres	21,536	0	18,040	1,505	1,350	-140	7,673	-3,614	20,910	8,961	3,960	0	6,172	86,353

[a] Excluding Wheeler Ridge-Maricopa Water Storage District.

Source: Appendix Tables A-1 to A-13.

Projected Acreages of Specialty Crops in California, Excluding the West Side

In Part I of this report the acreages of the specialty crops--defined here as tree fruits, nuts, grapes, and vegetables--were projected on the basis of "requirements" to meet demand at constant prices. This section projects "probable" aggregate acreages of these crops in the State on the basis of trends which have been occurring in the State over the past 15 years. Rather remarkable shifts in the location of production have occurred over this period as urbanization pressures have caused sizable relocations of acreage of specialty crops from the Central Coast and South Coast regions of the State into the Central Valley. Tree fruits (most deciduous fruits and oranges) and tree nuts (almonds and walnuts) have experienced substantial relocations over this period. Processed vegetables have also shifted, although unique climatic factors in the Coastal and Southern California areas have permitted those areas to retain much of their traditional fresh vegetable acreage.

Because of the rapid urbanization and shifts in crop location, any attempt to project acreages must proceed on a regional basis within California. The State has therefore been divided into eight areas--North Coast, Central Coast, South Coast, Sacramento Valley, San Joaquin Delta, San Joaquin Valley, Desert, and Intermediate Elevation Valleys. Within each of these regions the following steps were taken:

(1) The acreage of land well adapted for various types of specialty crop production was defined on the basis of soil and climate.

(2) The rate of urbanization and other nonagricultural uses of this high quality land were estimated and projected to 1980.

(3) The trends in aggregate acreages of tree fruits, nuts, grapes, and vegetables over the past 15 years were identified and projected at the same rate to 1980 and 1990.

(4) The total aggregate acreage of tree fruits, nuts, grapes, and vegetables was then compared with the agricultural land of high quality remaining after deducting for urban and other nonagricultural uses in order to judge whether the projected aggregate specialty crop acreage was plausible. If not, the projection of specialty crop acreage was adjusted downward accordingly.

The total land in each region well adapted for specialty crop production is taken from a study by Shumway, *et al.*, [1970] in which the State is broken down into 115 different soil-climate combinations identified as "homogeneous production areas." In this classification, the soils of the State were subdivided into 13 major categories. For the purpose of the present study, only "homogeneous production areas" comprised of soils in the top three classes--three grades of recent alluvial fan and flood plain soils of medium texture--were considered highly adapted to tree fruits, nuts, grapes, and vegetables.1/

The study by Shumway, *et al.*, [1970] projects urban acreage in the various "homogeneous production areas" on the basis of extending a previous study by Ruth and Krushkhov [1966]. The study identified "public land use," other than urban and agricultural production, which was assumed to remain constant through 1980. Finally, 10 percent of the remaining gross agricultural land (called "semiagricultural land") is assumed to be tied up in farmsteads, farm roads, canals, feedlots, crop failure, and idle land. Table 21 summarizes these data for the eight regions of the State. The Central Valley, particularly the San Joaquin Valley, contains the major acreages of the high quality soils in the State. The Central Coast contains sizable acreages of high quality land but urbanization has already taken large blocks out of agriculture with continued substantial conversions expected to 1980. The large block of high quality land in the desert area is not yet irrigated or scheduled for irrigation over the time horizon covered by this report. Thus, the data of Table 21 clearly reveals the concentration in the Central Valley of the high quality soils remaining for agricultural uses in the State.

Figures 7 through 14 summarize the current and projected land use of the high quality soils (three grades of recent alluvial fan and flood plain soils of medium texture) in each of the eight regions of California. Total acreage, urban land, public, and semiagricultural uses (10-percent waste of gross agricultural land) are taken from Table 21. In addition, Figures 7 through 14 show the aggregate acreages of tree fruits, nuts, grapes, and vegetables for the 15-year period, 1954-1968, together with projections to 1980, 1990, and 2000. In every case except the San Joaquin Delta region after 1980, projections are

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1/ The soil classification is based on a grouping of soil classes in an unpublished manuscript by Dr. R. E. Storie as recommended by Messrs. Eugene Begg and Gordon Huntington, Soil Specialists in the Department of Soils and Plant Nutrition, University of California, Davis.

TABLE 21

Land Use by Region of California, 1965 and 1980 Projections, for Recent Alluvial Fan and Flood Plain Soils of Medium Texture

Region	Total land in soil classes 01, 02, and 03[a]	Land use in 1965				Projected land use in 1980			
		Urban land	Public land use	Semi-agricultural land	Net potential agricultural land	Urban land	Public land use	Semi-agricultural land	Net potential agricultural land
	1,000 acres								
North Coast	77.0	2.9	4.2	7.0	62.9	5.0	4.2	6.8	61.0
Central Coast	861.8	177.2	32.9	65.3	586.4	271.7	32.9	55.7	501.5
South Coast	1,176.7	540.8	16.3	61.9	557.7	746.5	16.3	41.4	372.5
Sacramento Valley	744.9	32.9	12.8	69.9	629.3	56.5	12.8	67.6	608.0
San Joaquin Delta	579.5	72.1	13.2	49.5	444.7	102.4	13.2	46.4	417.5
San Joaquin Valley	3,030.6	113.8	69.3	284.7	2,562.8	167.3	69.3	279.2	2,514.8
Desert	1,471.3	19.8	83.9	136.7	1,230.9	41.1	83.9	134.7	1,211.6
Intermediate Elevation Valleys	170.3	5.6	17.9	14.7	132.1	9.8	17.9	14.3	128.3
STATE TOTAL	8,112.1	965.1	250.5	689.7	6,206.8	1,400.3	250.5	646.1	5,815.2

[a] Three classes of recent alluvial fan and flood plain soils of medium texture as defined by Shumway, *et al.* [1970].

Source: Shumway, *et al.* [1970, Table B.1].

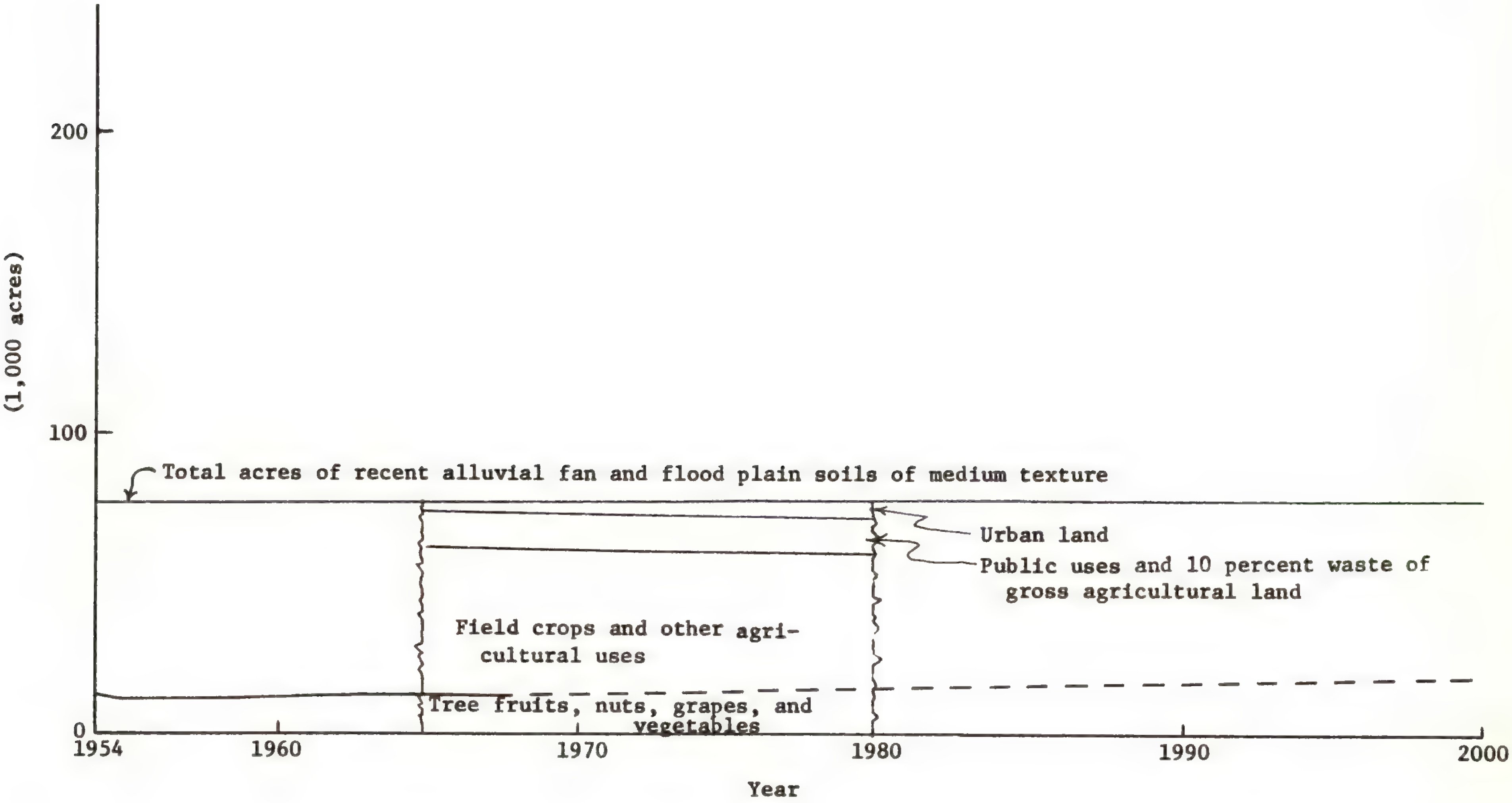

FIGURE 7. North Coast Region: Land Use on High Quality Soils

Source: Shumway, *et al.*, [1970]. California Crop and Livestock Reporting Service [1969a, b, c].

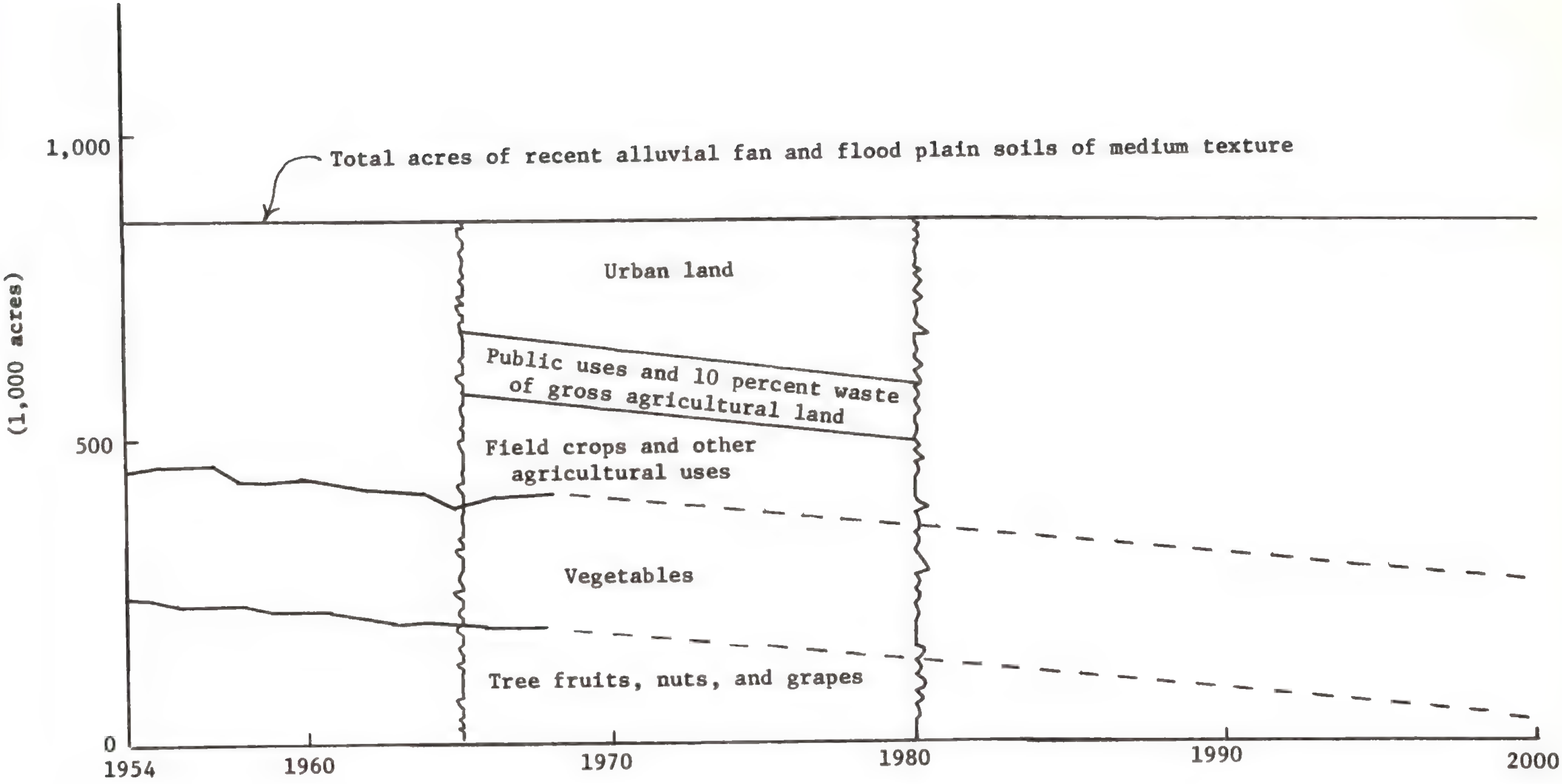

FIGURE 8. Central Coast Region: Land Use on High Quality Soils

Source: Shumway, *et al.*, [1970], California Crop and Livestock Reporting Service [1969a, b, c].

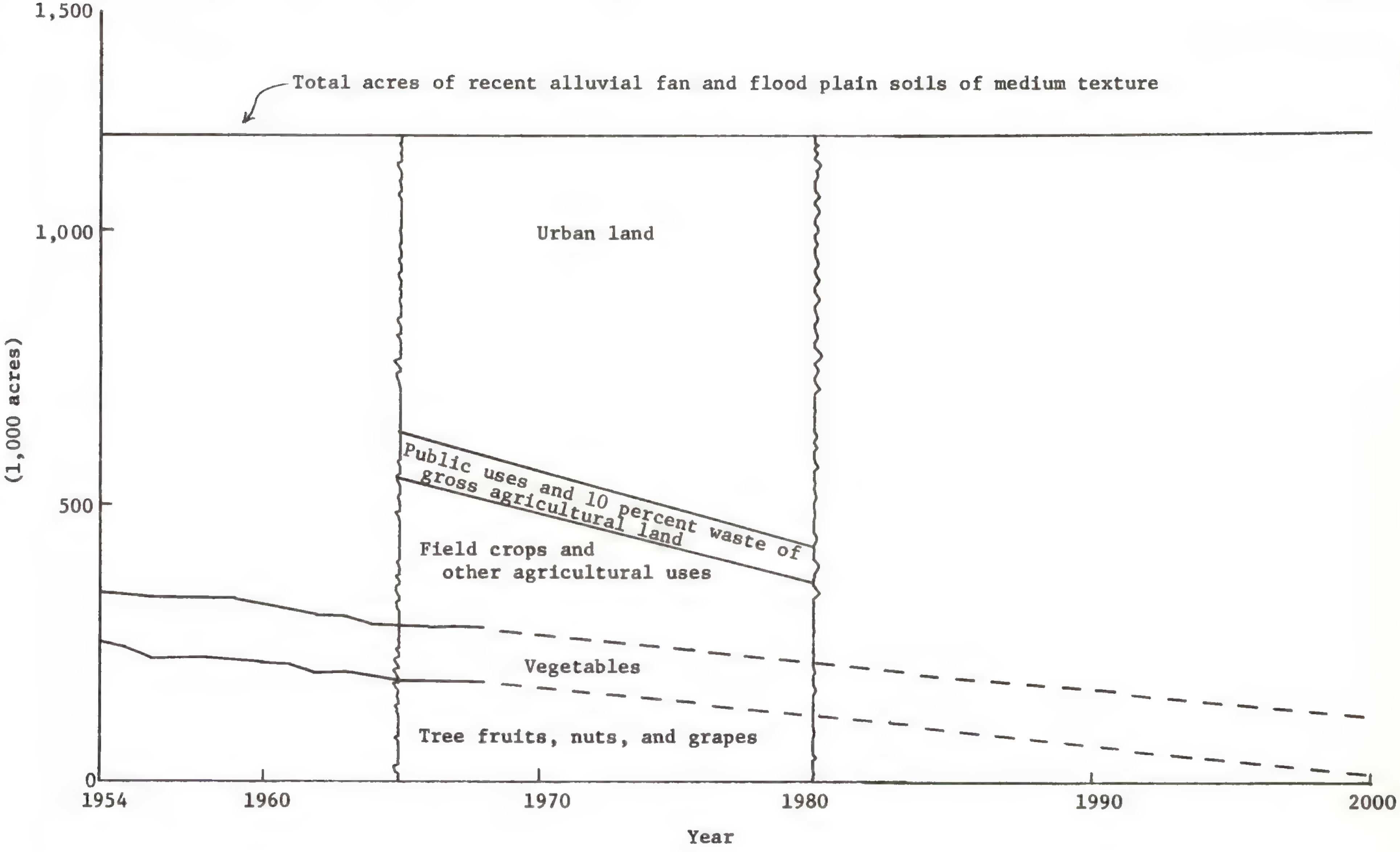

FIGURE 9. South Coast Region: Land Use on High Quality Soils

Source: Shumway, *et al.*, [1970 , California Crop and Livestock Reporting Service [1969a, b, c].

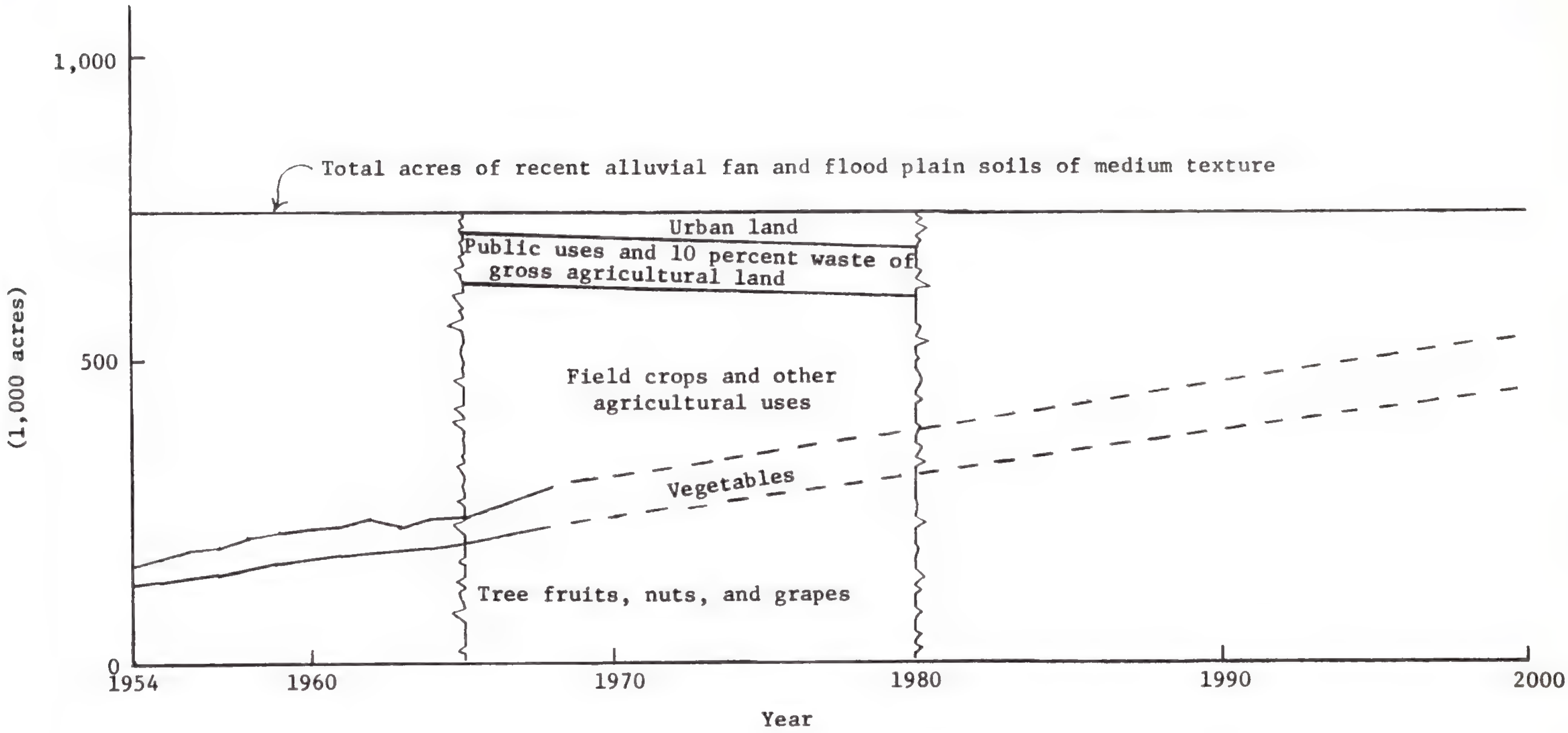

FIGURE 10. Sacramento Valley: Land Use on High Quality Soils

Source: Shumway, *et al.*, [1970], California Crop and Livestock Reporting Service [1969a, b, c].

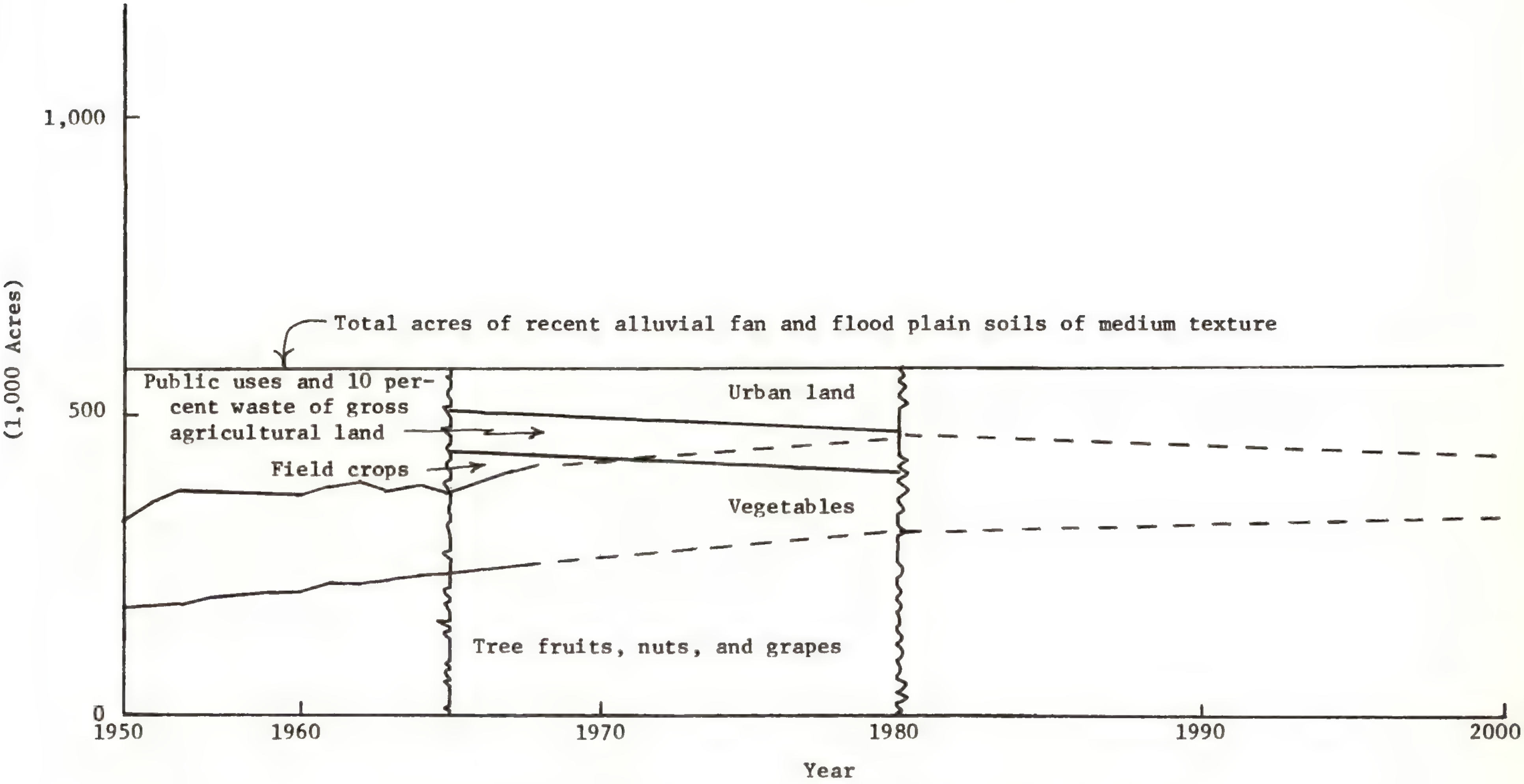

FIGURE 11. San Joaquin Delta: Land Use on High Quality Soils

Source: Shumway, *et al.*, [1970], California Crop and Livestock Reporting Service [1969a, b, c].

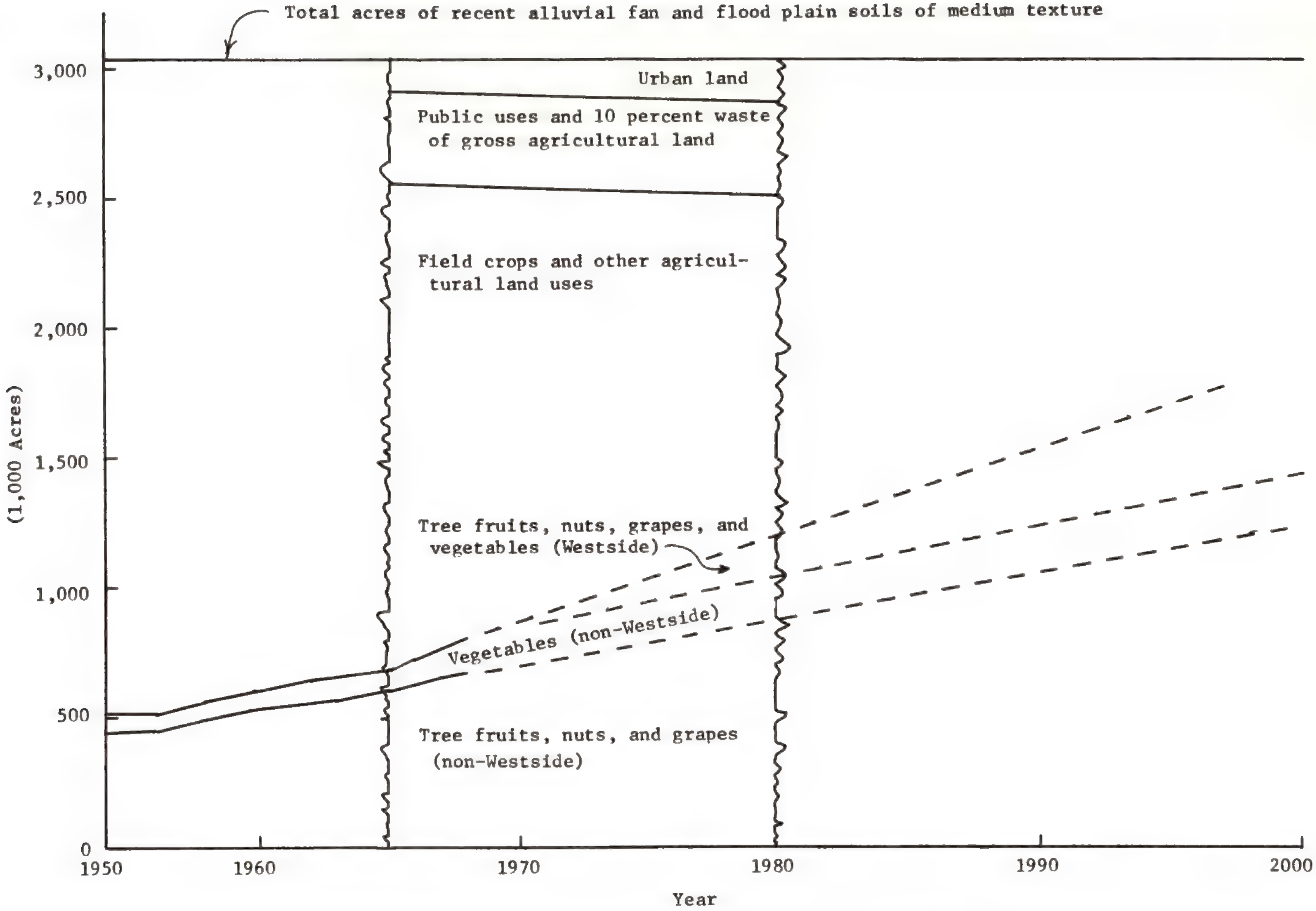

FIGURE 12. San Joaquin Valley: Land Use on High Quality Soils

Source: Shumway, *et al.*, [1970], California Crop and Livestock Reporting Service [1969a, b, c].

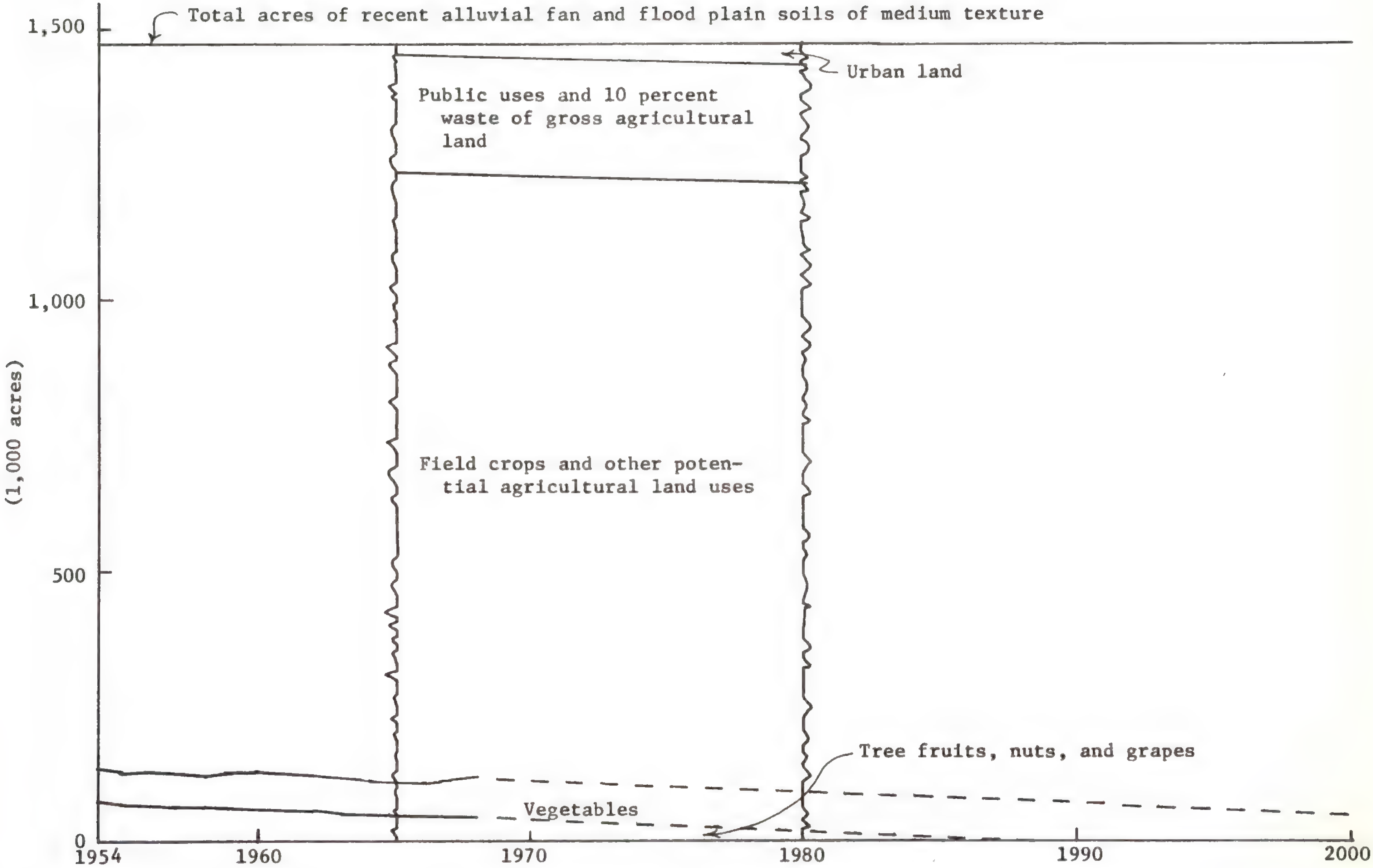

FIGURE 13. Desert Region: Land Use on High Quality Soils

Source: Shumway, *et al.*, [1970], California Crop and Livestock Reporting Service [1969a, b, c].

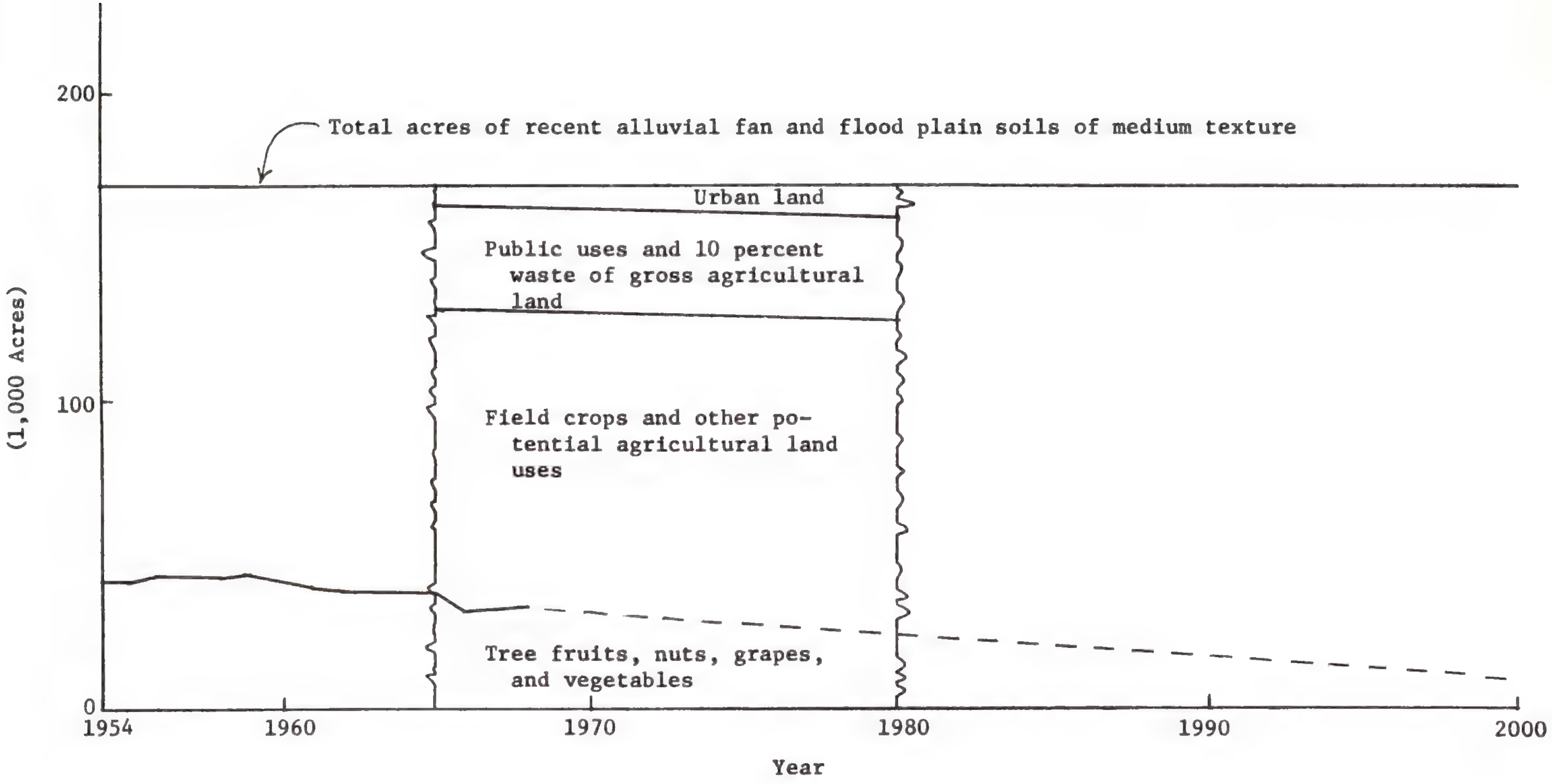

FIGURE 14. Intermediate Elevation Valleys: Land Use on High Quality Soils

Source: Shumway, *et al.*, [1970], California Crop and Livestock Reporting Service [1969a, b, c].

simply linear extrapolations of the trends taking place over the 1954 to 1968 period.[1]

Figures 8 and 9 show the rapid rate of urbanization in the Central Coast and South Coast regions. However, even if urbanization continued at the 1965 to 1980 projected rate, there appears to be adequate high quality land remaining after urbanization and other nonagricultural uses to permit continued crop production use of the projected reduced acreages of the specialty crops by 1990 and probably 2000 as well.

Counterbalancing the losses in specialty crop acreage in the coastal regions are sharp increases in the three Central Valley regions--the Sacramento Valley, the San Joaquin Delta, and the San Joaquin Valley (Figures 10, 11 and 12). Here again, the projected net acreage of high quality land remaining to agriculture appears sufficient to produce the projected acreages of specialty crops in the Sacramento Valley and San Joaquin Valley regions. However, Figure 11 shows that the acreage of high quality land remaining in the San Joaquin Delta may be limiting. This picture is perhaps somewhat misleading in that the county acreages used in estimating the specialty crop acreages include slightly more land than is defined by Shumway's "homogeneous production areas" making up the Delta. Furthermore, an unknown proportion of the vegetables are double-cropped so that less net acreage is required than shown in Figure 11. Therefore, the aggregate projected acreages of specialty crops were permitted to expand linearly to 1980. However, thereafter, the aggregate acreage of specialty crops declines at about the same rate as urban acreage is projected to expand.

Figure 12 shows the situation in the San Joaquin Valley where the largest blocks of high quality soils are available in the State. The projections of specialty crop acreages here are broken into two parts. First, projections are made for tree fruits, nuts, grapes, and for vegetables in the "nonwest side" area; i.e., all parts of the Valley except the west side acreage to be affected by California Aqueduct water. Since the acreage of specialty crops in these areas was insignificant up until 1968, the "nonwest side" acreage was projected, based on the 15-year trend in San Joaquin Valley specialty crop acreages. Second, the projection of west side specialty crop acreage (from Table 20) is added to the nonwest side specialty crops acreage to obtain the aggregate acreages of tree fruits, nuts, grapes, and vegetables in the San Joaquin Valley.

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[1] More specifically, the average aggregate acreages for the three-year periods, 1954 to 1956 and 1966 to 1968 were calculated. Then average rate of annual change between these two dates was extrapolated into the future.

Some summary comments regarding Figures 7 through 14 are in order. The acreages of specialty crops in each region were projected at a linear rate in lieu of a more refined procedure. Given these projections, there appears to be sufficient high quality net agricultural land remaining to meet these projections without difficulty. Of course, some lower quality land (not shown in Figures 7 through 14) will be used to produce the specialty crops and some of the high quality land will be used for field crops. But the comparison of specialty crop acreage with high quality land provides a rough measure of the feasibility of the projected specialty crop acreages.

Comparison of Specialty Crop Acreage Projections with Acreage "Requirements"

It is now possible to compare the aggregate projected State acreage of specialty crops (from Figures 7 through 14) with the earlier projected acreages which would be "required" from California to meet demand at constant prices (from Tables 4 and 5, Part I). Table 22 shows the comparisons for 1980, 1990, and 2000. In 1980 there is an "excess" of 76,000 acres of tree fruits, nuts, and grapes and 51,000 acres of vegetables; i.e., these are the projected acreages in excess of those which would be required to meet demand at constant prices. The aggregate "excess" acreage of specialty crops is 127,000 acres compared with a projected 154,000 acres to be developed on the west side. The level of "excess" acreage continues high for 1990 and 2000, although the assumptions affecting demand and supply become more conjectural as the time horizon lengthens. If these projections are accurate, most of the specialty crop acreage on the west side will act to depress prices.

Table 22 shows that there is a potential aggregate excess acreage of specialty crops in California. The price effects, however, must be evaluated on a crop by crop basis. In order to do so, it is necessary (1) to project an allocation of the aggregate "excess" acreage and quantity supplied among individual crops and (2) to investigate the price elasticities of demand for the individual crops. Table 23 provides two alternative allocations of the

TABLE 22

Comparison of Projected Acreages of Specialty Crops with Acreages "Required" at Constant Prices[a]

Region	1980			1990	2000
	Tree fruits, nuts, and grapes	Vegetables	Total tree fruits, nuts, grapes, and vegetables	Tree fruits, nuts, grapes, and vegetables	Tree fruits, nuts, grapes, and vegetables
	acres				
North Coast	15,000	--	15,000	17,000	19,000
Central Coast	145,000	225,000	370,000	320,000	270,000
South Coast	120,000	100,000	220,000	170,000	120,000
Sacramento Valley	310,000	70,000	380,000	460,000	540,000
San Joaquin Delta	310,000	160,000	470,000	455,000	440,000
San Joaquin Valley (nonwestside)	880,000	170,000	1,050,000	1,255,000	1,460,000
San Joaquin Valley (west side)	65,000	89,000	154,000	254,000	254,000
Desert	20,000	70,000	90,000	70,000	50,000
Intermediate Elevation Valleys	24,000	--	24,000	16,000	8,000
State acreage projected	1,889,000	884,000	2,773,000	3,017,000	3,161,000
State acreage "required"	1,813,000	833,000	2,646,000	2,796,000	2,947,000
State "excess acres"	76,000	51,000	127,000	221,000	214,000

[a] Vegetable acreage does not include potatoes.

Source: Figures 7-14 and Tables 4 and 5.

TABLE 23

Two Alternative Allocations of 1980 "Excess" Acres and Supply Among Fruits, Nuts, Grapes, Vegetable Crops, Potatoes, and Alfalfa Seed

Crop category	Allocation A[a]			Allocation B[b]		
	"Excess" acres		Percent "excess supply" relative to relevant market size	"Excess" acres		Percent "excess supply" relative to relevant market size
	acres		percent	acres		percent
Fruits, nuts, and grapes	76,000			107,000		
Deciduous fruits		23,000	3.5		30,000	4.6
Almonds		23,000	8.2 (5.0)[c]		30,000	10.7 (6.6)[c]
Grapes		10,000	2.0		20,000	4.0
Oranges		20,000	1.7		27,000	2.3
Vegetables	51,000			50,000		
Cantaloupes		10,000	9.8		5,000	4.9
Other vegetables		41,000	2.1		45,000	2.3
Potatoes, early spring	19,000		26.0	10,000		13.3
Alfalfa seed	36,000		8.0	15,000		3.8
TOTAL, above crops	182,000		--	182,000		--

a/ General allocation for fruits, nuts, grapes, and for vegetables from Table 22; allocation within each category according to west side projected acreage. "Excess" acres for potatoes and alfalfa seed equal to west side acreages.

b/ Allocation based on judgment considering recent trends.

c/ Figure in parentheses relevant if all tree nuts considered competing market. Figure not in parentheses relevant if almonds only considered competing market.

"excess" acreage and supplies. The demand elasticities are investigated in the next section of the report.

Under Allocation A in Table 23, the 76,000 "excess" acres of tree fruits, nuts, and grapes (from Table 22) are divided among deciduous fruits, tree nuts, grapes, and oranges according to the relative acreages projected for the west side.[1/] The 51,000 excess acres of vegetables (from Table 22) are divided among cantaloupes and other vegetables on the same basis. In addition, Table 23 shows 19,000 excess acres of early spring potatoes and 36,000 acres of alfalfa seed--equal to the planned 1980 west side acreages. It appears that other parts of Kern County and the Central Valley (mainly the San Joaquin Valley) could meet the demand for early spring potatoes and alfalfa seed from current acreages. Since both potatoes and alfalfa seed are crops with relatively high value per acre, they are important to the District plans to provide adequate payment capacity for irrigation water. However, because they have limited markets, it seems appropriate to include them among the crops that might experience price effects from west side development.

The 1980 "excess" acreage of each crop was then multiplied by 1980 projected yields to obtain "excess" California quantities supplied. This "excess" California supply was then calculated as a percentage of the relevant total U.S. market for each crop or crop category. For deciduous fruits, there is an excess supply of 3.5 percent relative to the aggregate 1980 U.S. projected quantity of all deciduous fruits (excluding apples). Almonds are in 8.2 percent excess supply relative to the projected U.S. almond market but only 5.0 percent if compared in relation to all tree nuts (both almonds and walnuts). Perhaps the latter figure is more relevant since almonds and walnuts are to some extent competitive products. Grapes are in 2.0 percent excess supply and oranges 1.7 percent excess supply. Vegetables, particularly cantaloupes, are also in excess supply. Early spring potatoes are in excess supply by an order of magnitude of 25 percent. This is because the demand for potatoes could be met with constant acreage and California produces about two-thirds of the early spring potatoes in the United States yet the Westside District plans call for an additional 19,000 acres of early spring potatoes compared to around 50,000

[1/] The acreage of deciduous fruits and almonds were combined into a single category in many irrigation district projections. Therefore, half of the acreage in the category was allocated to deciduous fruits and half to almonds.

acres required at constant prices and now being grown elsewhere. Alfalfa seed acreage is also up by 36,000 acres on the west side, or an 8 percent excess supply compared to the U.S. 1980 projected "requirement." It is likely that the required California acreage of alfalfa seed estimated earlier in Table 3 is high since it is predicated on no increase in average yields. Thus, it appears likely that the areas of the State currently growing alfalfa seed have sufficient acreage to meet California's share of the U.S. demand.

Allocation B in Table 23 is based on a reallocation of the 182,000 "excess" acres among the individual crops on a judgment basis. Based on initial plantings on the acreage thus far developed on the west side, the authors have reduced the acreage allocated to potatoes, alfalfa seed, and cantaloupes and increased the allocation to fruits, nuts, and grapes. This results in less drastic percentages of excess supply in the former but higher percentage excess supplies in the latter.

The following section examines in more detail the demand characteristics of the crops shown to be in "excess" supply at constant prices in 1980. In particular, price elasticities of demand are needed to convert percentage excess supplies into percentage changes in prices.

DEMAND CONSIDERATIONS FOR COMMODITIES OF IMPORTANCE FOR THE WEST SIDE

This section attempts to point out the nature of the demand for the key agricultural crops being considered for production on the newly irrigable west side lands of the San Joaquin Valley. Demand considerations are critical in tracing through the market implications for prices and profits of the increased levels of production brought about by the developments on the west side. Because the markets for many of the specialty crops are quite limited, prices are sensitive to moderate shifts in demand and supply. Market considerations are particularly critical for orchard crops where there is a lag between plantings and bearing acreage.

Tree Fruits, Nuts, and Grapes

Deciduous Fruits

Deciduous tree fruits generally considered suitable for selected locations of the west side include apricots, plums, nectarines, clingstone peaches, and freestone peaches. A detailed analysis of these five tree fruits recently has been published by Kip and King [1970]. The conclusion of this study is that there is limited potential for expanded acreage for these crops; in fact, it shows that if 1961-65 prices are to be maintained with projected yield increases, a decrease in acreage is required for the aggregate of these five crops. However, due to regional shifts in location of production, expansion of acreage perhaps by about 20,000 acres in the San Joaquin Valley by 1980 is indicated to offset decreases expected in the Central Coast and in Southern California.

The State data on bearing and nonbearing acreage of apricots, plums, clingstone peaches, and freestone peaches are given in Figure 15. If the analysis of demand for 1980 is correct and, with yield increases expected by 1980, the bearing acreage of apricots consistent with 1961-65 average prices would be about 30,000 acres, as compared with current bearing acreage of about 35,000 acres. Similar analyses for plums as well as nectarines indicate an increase in bearing acreage for these crops.

According to Kip and King [1970], the estimated acreage of clingstone peaches "required" to meet 1980 demand at 1961-65 average prices is about 59,000 bearing acres or somewhat less than at present. This estimate is considerably below that presented in Table 5 based on aggregate U.S. demand for deciduous tree fruits, which indicated an acreage of about 81,000 bearing acres. It would appear that the lower estimate is more in line with current expectations as to the demand for clingstone peaches. On the other hand, the Kip-King estimate of 1980 bearing acreage for freestone peaches of about 32,000 bearing acres is slightly higher than the 28,000 given in Table 5. It is clear that producers should give full consideration to the market implications of increasing acreage of deciduous tree fruits in the near future. The detailed analysis by Kip and King develops this point more fully than can this brief statement.

Oranges

There are apt to be serious marketing problems for California oranges in the next decade due to the expanded acreage both in California and in Florida and the nature of the demand for citrus fruit. Navel orange acreage has increased markedly (as shown in Figure 16) from a total of about 62,000 acres in 1956 to over 110,000 acres in 1968. The full impact of this acreage has not

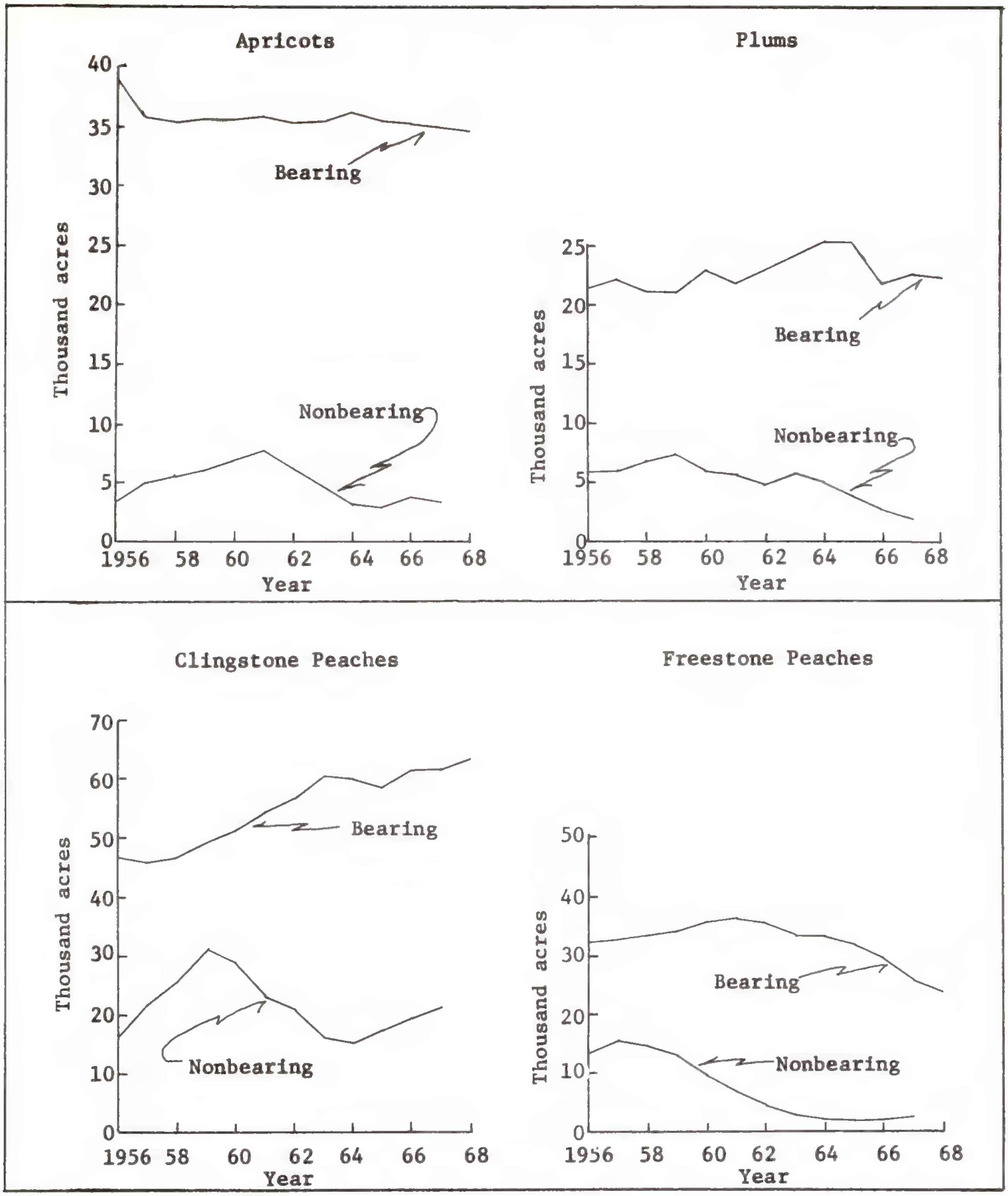


FIGURE 15. Selected Deciduous Tree Fruit Acreage, California

Source: California Crop and Livestock Reporting Service [1969b].

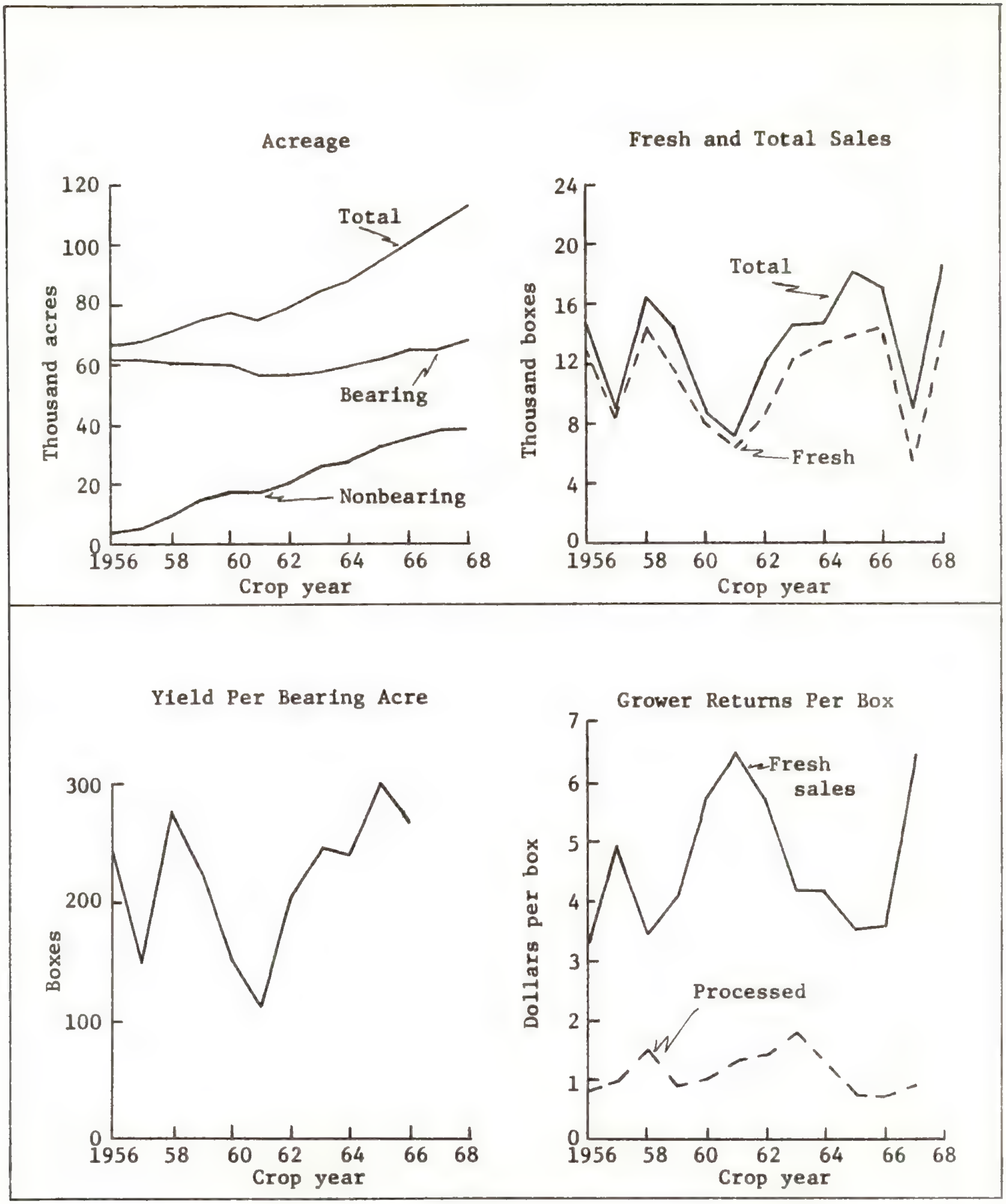


FIGURE 16. California Navel and Miscellaneous Oranges--Acreage, Sales, Yield, and Grower Returns Per Box

Source: California Crop and Livestock Reporting Service [1969b].

been felt since nonbearing acreage accounts for almost 40,000 acres. Most navel oranges are sold fresh, where returns are higher than in the processed market. In a recent statement assessing the industry in the next decade, D. F. McMillen [1970] of Sunkist Growers projects that an increasing share of the navel oranges probably will be utilized in the processed market. Further, he emphasizes the problems facing the industry in marketing the future level of production reflected in the current bearing and nonbearing acreages of both navels and Valencias.

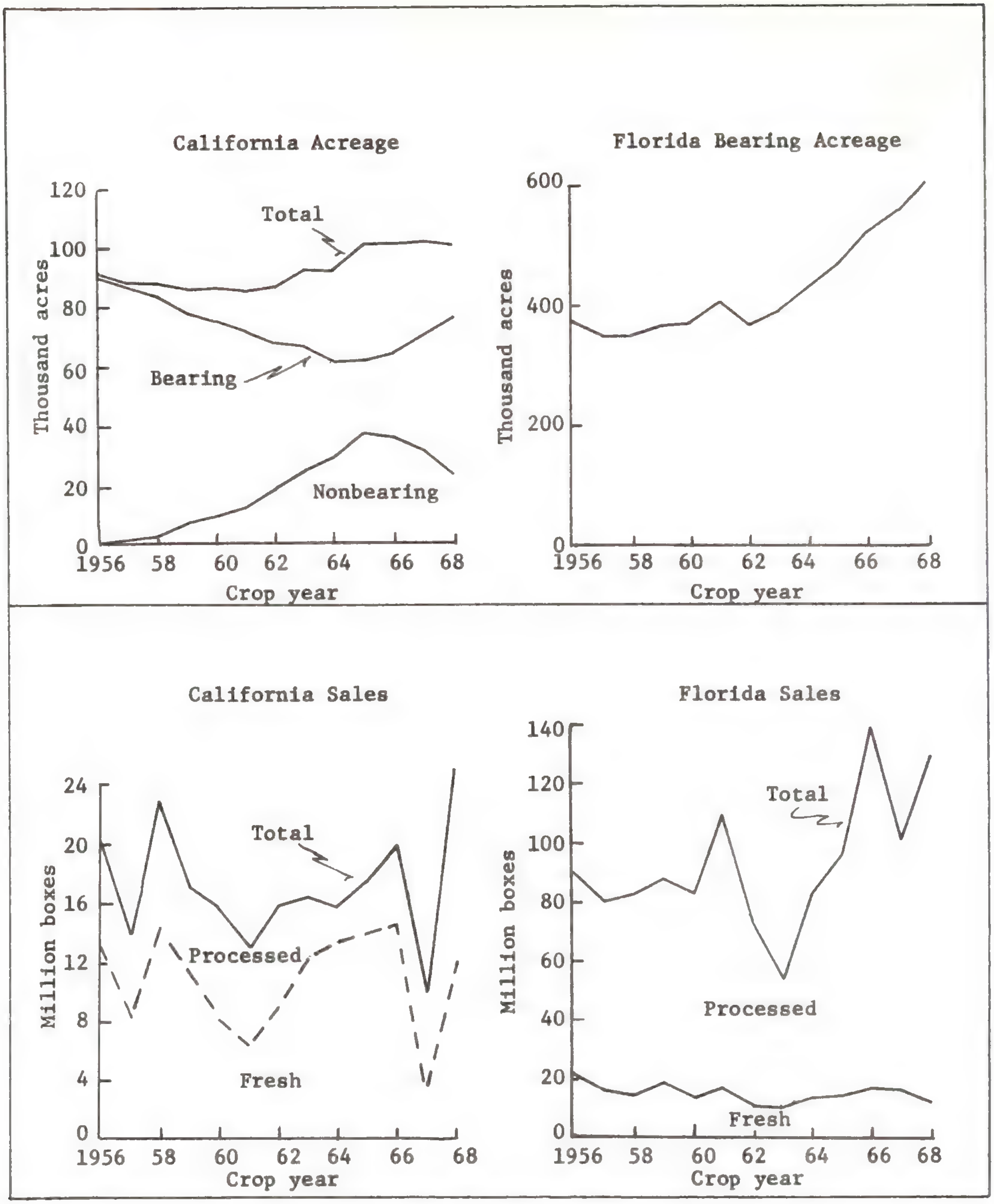
Valencias have been more dependent on the processing market than have navels although, currently, the fresh sales predominate (see Figure 17). Projections for the 1975 crop indicate the processing market to account for about 50 percent of sales, according to data presented by McMillen [1970]. The Florida bearing acreage also has increased sharply in recent years, with 1968 bearing acreage at about 600,000 acres. The major proportion of this crop is processed.

The producer problem is reflected in Figure 18. Net returns increased steadily over the period from 1947, but in recent years, have declined sharply, resulting in negative net returns per acre in 1967--the latest data available at this time. Cultural costs have continued to increase but grower gross returns have declined due to the increased production and the fairly inelastic demand for oranges. Essentially, population and income effects have not shifted the demand for oranges at a sufficiently rapid pace to allow the increased production to be sold at favorable prices.

Almonds

There have been sharp increases in both nonbearing and bearing acreages of almonds in California (as shown in Figure 19). Much of the recent increase in nonbearing acres has come in the San Joaquin Valley. Yield increases are expected as these new plantings come into production. The yield for the 1969 crop was 0.91 tons per acre, resulting in a record crop of about 120,000 tons (in-shell basis).

Most of the California crop is shelled and sold to confectioners, salters, bakeries, and ice cream manufacturers. Only about 10 percent of the crop is retailed directly. The domestic shelled sales have increased with favorable



California Acreage

Florida Bearing Acreage

California Sales

Florida Sales

FIGURE 17. California Valencia Oranges and Florida Oranges, Acreage and Sales, 1956-68

Source: Florida Crop and Livestock Reporting Service, Citrus Summary [1969]; California Crop and Livestock Reporting Service [1969b].

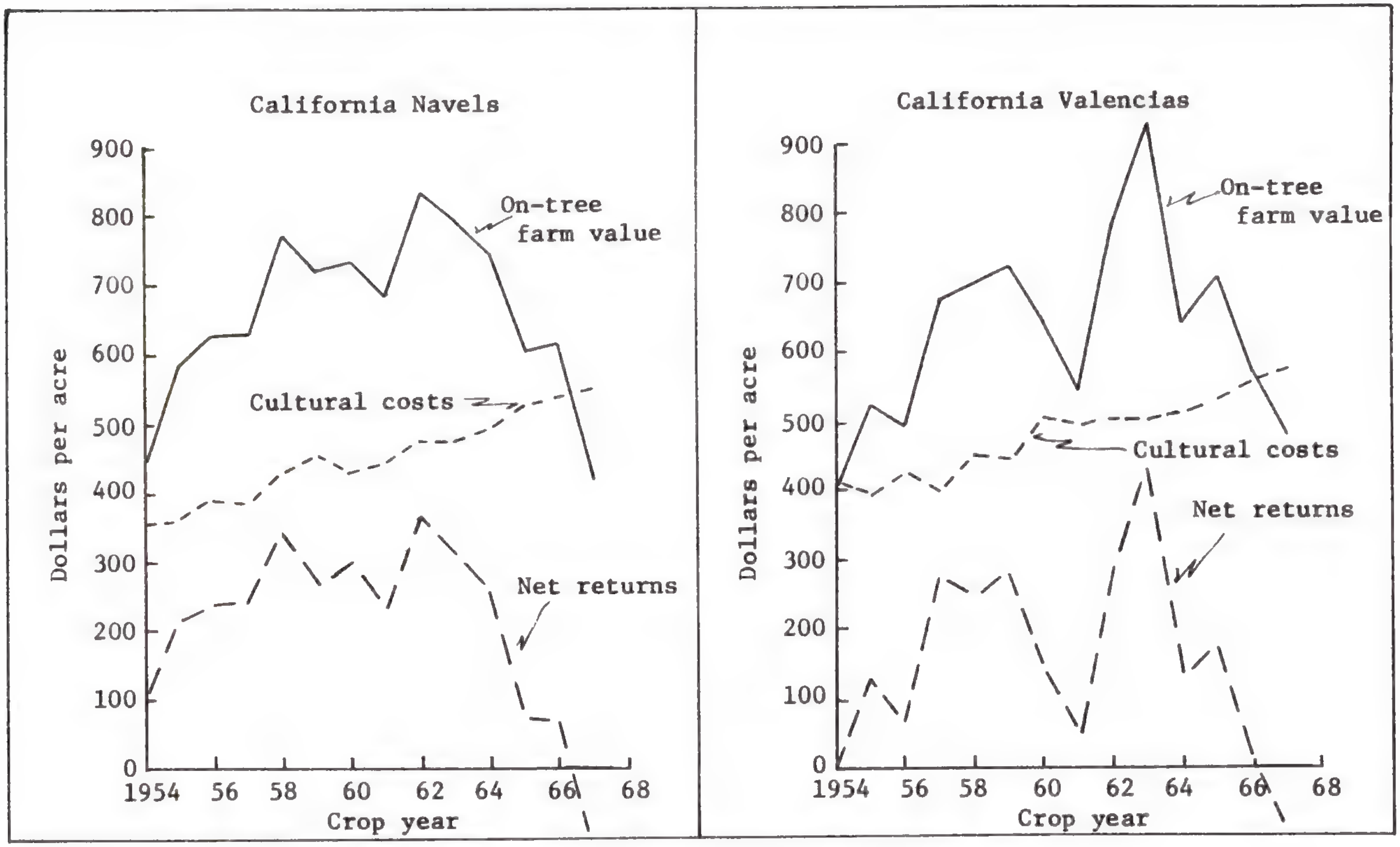


FIGURE 18. California Navel and Valencia Oranges, Per Acre Value, Cultural Costs, and Net Returns

Source: Sunkist Growers [1969].

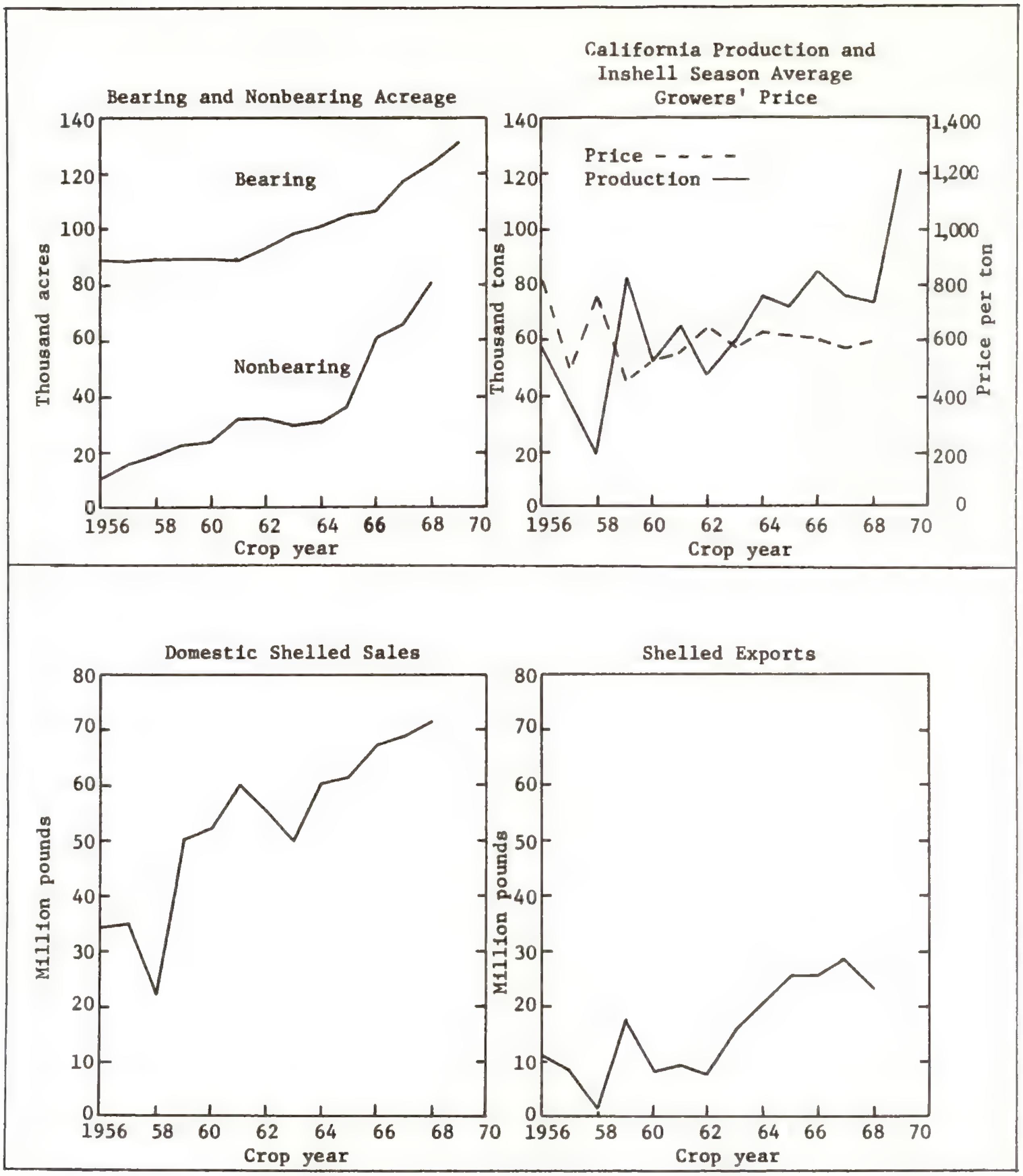


FIGURE 19. Almond Acreage, Production, and Sales

Source: Almond Control Board [1969].

market acceptance of almond products. Domestic market expansion is limited by competition from other tree nuts, such as walnuts, filberts, pecans, cashews, and Brazil nuts. Favorable grower prices with the higher production levels are due, in part, to the growing export market for almonds.

"The California almond industry is under a marketing order which designates a certain percentage (about 85 percent usually) as salable domestically and 15 percent as surplus which must be disposed of in noncompetitive domestic uses or in foreign markets but this percentage in exports has been exceeded recently due to favorable foreign prices" (Johnston and Dean [1969, p. 46]). The export market thus becomes of great importance to the economic position of the industry as large blocks of nonbearing acreages come into production. In 1969, large exports were possible due to the low production especially in Italy, where production dropped from 47,000 tons (shelled) in 1968-69 to 25,000 tons in 1969-70. Total foreign production for these years decreased from 107,500 tons to 69,000 tons, according to preliminary estimates published by the Almond Control Board [1969]. However, with normal levels of foreign production, there will be increased competition in the export markets. It would appear that further expansion of almond acreage would result in a level of production in excess of that consistent with current producer prices. With yield levels similar to the favorable 1969 crop, overproduction appears likely with current levels of domestic and export demand.

Grapes

Total acreage of grapes was 479,021 in the 1961-65 period of which 447,058 was bearing and 31,963 nonbearing acres. Production is concentrated in the San Joaquin Valley although other areas are important for high quality wine grapes. The bearing acreage of grapes is not expected to increase markedly in the near future since increased yields will probably provide the required production.

Total sales have averaged over 3 million tons in recent years of which about 50 percent is crushed, 15 percent is for fresh use, and 35 percent is dried. Minor quantities are canned. The export market is of particular importance for raisins (as shown in Figure 20). Fresh market sales have remained at about 525,000 tons but per capita sales have decreased in the postwar period from 4.7 pounds (retail) in 1949 to 3.1 pounds in 1968. Wine

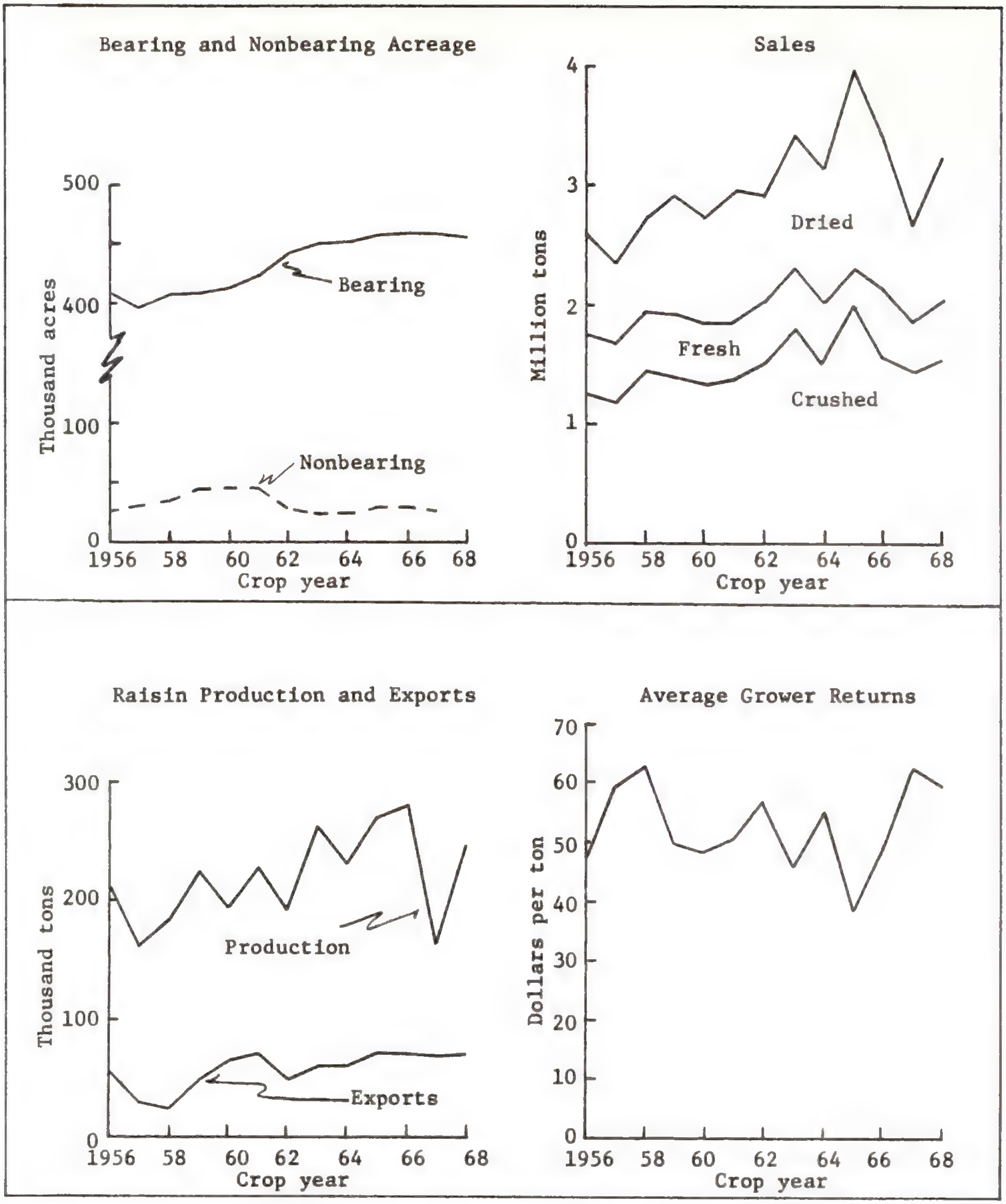


FIGURE 20. Grapes, Acreage, Sales, and Grower Returns

Source: California Crop and Livestock Reporting Service [1969b].

consumption, on the other hand, has increased in per capita terms from 0.888 gallons in 1958 to 1.026 gallons in 1967 as reported by the Wine Institute [1968]. Trends in wine consumption therefore will be of major importance to the grape industry in California.

Demand Elasticities

There are two important aspects of the demand for agricultural products: the first is the level of the demand curve relating price and quantity and the second is the slope or elasticity of demand at a particular point. The level of demand is influenced by population, income, and competing commodities. Estimates of the consumption per capita in 1980 are given in Table 24 for important fruits. These estimates are based on the assumption that prices remain at 1964 levels, corrected for changes in the general price level. These estimates are based on income elasticity coefficients; i.e., the effect on quantity consumed of a 1-percent change in income, holding prices constant. Real income per capita is projected to increase by 41.9 percent between 1962 to 1966 and 1980, based on estimates provided by Daly and Egbert [1966a]. The nature of this calculation is illustrated for oranges as follows: consumption per capita in the 1962-66 period was 14.5 pounds, retail weight. The income elasticity (.260) is multiplied by the percentage increase in income (41.9), giving a 10.9-percent increase in consumption per capita, or a 1980 level of 16.0 pounds (14.5 x 110.9). Similar calculations are made for other commodities. Due to the fairly low income elasticities, consumption per capita does not increase markedly to 1980. The total consumption, however, will increase due to the projected increase in population from 192.1 in 1964 to 235.2 million in 1980.

The price elasticity of demand for most agricultural commodities is inelastic or less than 1.0 (negative sign ignored), as is seen in Table 24. The farm level elasticities are generally lower than at retail. The importance of this fact is that a given decrease in price will result in a less than proportionate increase in consumption. The price elasticity estimate for oranges is -.663. This implies that if prices decrease by 10 percent, quantity consumed will increase by only 6.6 percent and total revenue will be lower. Thus, if production of these crops is expanded rapidly in relation to demand, prices will be depressed as will revenues to producers.

TABLE 24

Fruits, Nuts, and Grapes: Price and Income Elasticities, and Consumption Per Capita, 1962-66 and 1980

Crop category	Price elasticity (retail)a/	Income elasticitya/	Consumption per capita (retail weight) 1962-66b/	1980a/
			pounds	
Fruits				
Fresh				
Apples	- .720	.140	17.2	18.2
Bananas	- .615	.140	17.0	18.0
Oranges	- .663	.260	14.5	16.0
Nectarines	-1.057c/	.104c/	.6	.6
Peaches	- .898c/	.386c/	6.5	7.5
Plums	- .630c/	.570c/	1.3	1.6
Other	- .600c/	.400c/	20.7	24.2
TOTAL			77.8	86.1
Canned				
Peaches	- .759	.341	6.4	5.3d/
Pineapple	- .823	.447	3.1	3.6
Other	- .400	.200	13.5	13.5
TOTAL			23.0	22.4
Dried fruits	- .655	.315	2.9	2.2d/
Other items				
Canned juice			11.6	11.6
Chilled fruit and juice			2.0	2.0
Chilled citrus segments			.4	.4
Frozen fruits	-1.000	.661	3.7	4.7
Frozen citrus juice			4.6	5.9
TOTAL			22.3	24.6
Total Fruit				
Product weight			126.0	135.3
Fresh equivalent			171.6	
Nuts (shelled basis)				
Almonds	-1.307e/		.27f/	
Pecans			.41f/	
Walnuts			.33f/	
Other			.61f/	
TOTAL			1.62f/	
Grapes (wine)	- .232g/			

a/ P. S. George and G. A. King [1969].

b/ S. J. Hiemstra [1968].

c/ Ergun Kip and Gordon A. King [1970].

d/ Based on positive income elasticity but negative time trend.

e/ Richard M. A. Loyns [1968].

f/ U.S. Department of Agriculture, Economic Research Service [1969].

g/ Bertrand Renaud [1966].

Vegetables

Analysis of trends for individual vegetable crops is beyond the scope of this report. However, Appendix B provides data on the per capita consumption of vegetables in recent years. A summary of the price and income elasticity coefficients for major items is provided in Table 25. For vegetables, the income elasticity coefficients are relatively low and the price elasticity coefficients tend to be lower than for fruits. The same interpretation of elasticity coefficients applies for vegetables as for fruits.

One commodity group (melons), is singled out for consideration since melons (principally cantaloupes) are included prominently in the project plans for several of the newly irrigated lands on the west side. Figure 21 provides recent trends in production and prices of watermelons, cantaloupes, and honeydew melons. Although no recent studies are available as to the demand elasticity, an estimate of -.5 may be taken for purposes of comment. This implies that a 10-percent reduction of price is associated with a 5-percent increase in quantity consumed.

Cotton

Projections of the demand for cotton are particularly difficult due to the impact of synthetic fibers on both domestic and foreign markets. The estimates presented earlier in the report were based on the 1966 report by Daly and Egbert [1966b]. Since that time, the competitive position of cotton has continued to decline in relation to competitive fibers in all end-use markets. This section provides a brief review of these trends and an alternative estimate of the U.S. demand for cotton in 1980 is given, based on more pessimistic estimates of the domestic and export markets.

The major trends (shown in Figure 22) may be summarized briefly as follows: (1) cotton's share of the fiber market, which was 70 percent in 1951, is estimated at 40 percent in 1969; (2) sharp decreases in the price of polyester fibers has meant that these fibers can now compete on a price basis with cotton, especially when allowance is made for milling waste; (3) per capita consumption of cotton has trended downward to about 21 pounds per capita whereas all fiber consumption has increased; (4) mill consumption of cotton has remained at about 4 million pounds annually, with population increases offsetting the declining

TABLE 25

Vegetables: Price and Income Elasticities, and Consumption Per Capita, 1962-66 and 1980

Crop category	Price elasticity (retail)a/	Income elasticitya/	Consumption per capita (retail weight)	
			1962-66b/	1980a/
			pounds	
Vegetables				
Fresh				
Lettuce	- .141	.147	19.0	20.2
Tomatoes	- .385	.170	10.4	11.2
Beans, snap, and lima	- .255	.000	2.3	1.7
Onions	- .250	.005	10.9	10.9
Carrots	- .497	.319	6.6	7.3
Other	- .320	.150	42.4	45.1
TOTAL			91.7	96.4
Canned				
Peas	- .185	.032	4.1	2.0
Corn	- .255	.023	5.5	5.5
Tomatoes, whole	}- .176	.173	4.5	5.0
Tomato products			14.1	15.1
Other	- .400	.200	17.9	19.3
TOTAL			46.1	46.9
Frozen	-1.034	.610	8.2	10.3
TOTAL (retail)				
Product weight			146.0	153.6
Fresh equivalent			194.1	
Dry edible beans	- .480	.217	7.2	2.3
Potatoes				
Fresh	- .309	.117	92.4	87.6
Canned			.4	.4
Frozen			5.4	8.6
TOTAL				
Product weight			98.2	96.6
Fresh equivalent			106.2	
Sweet potatoes				
Fresh	- .520		4.4	1.5
Canned			1.2	1.2
TOTAL				
Product weight			5.6	2.7
Fresh equivalent			5.7	

a/ George and King [1969].

b/ Hiemstra [1968].

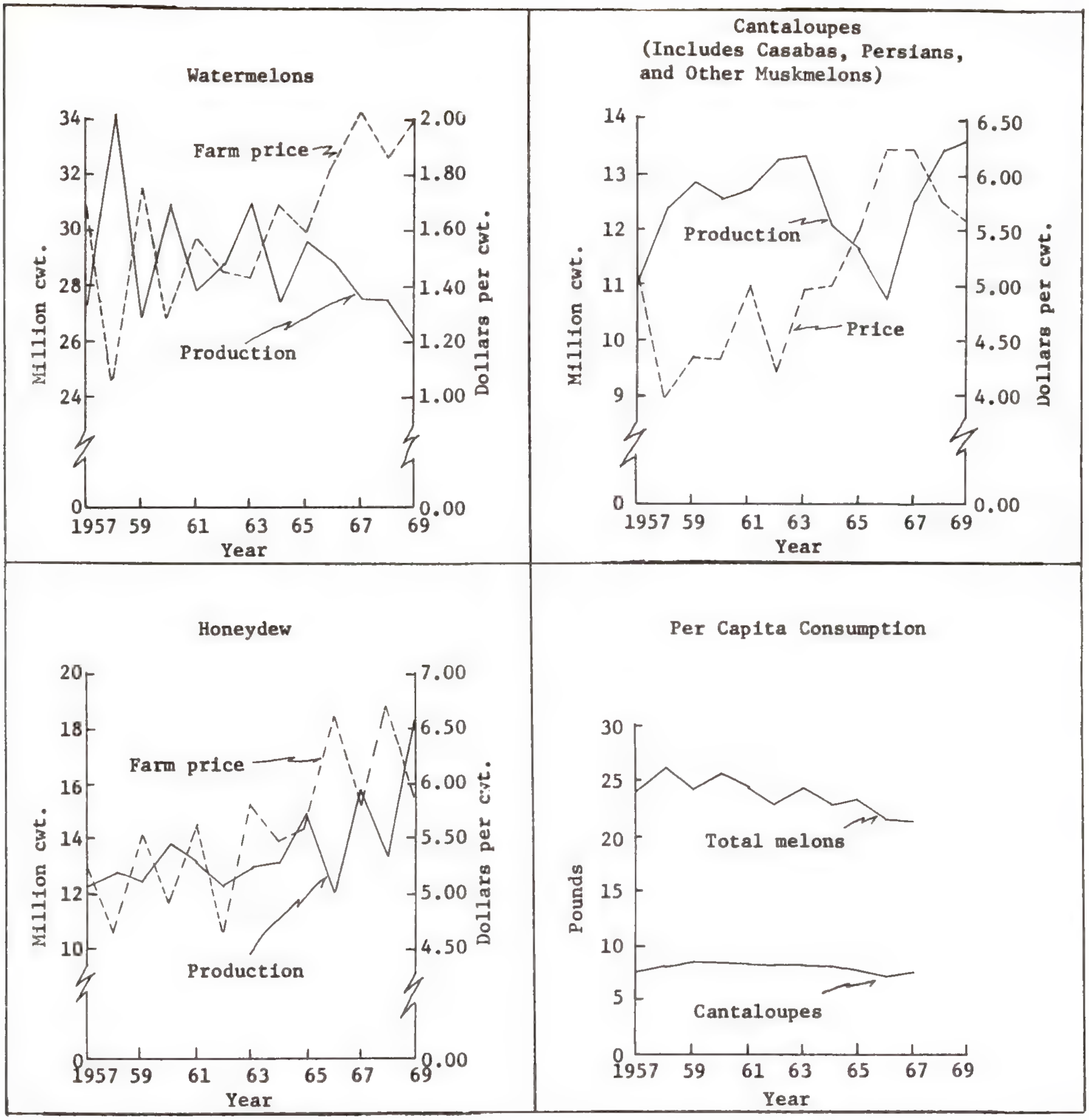
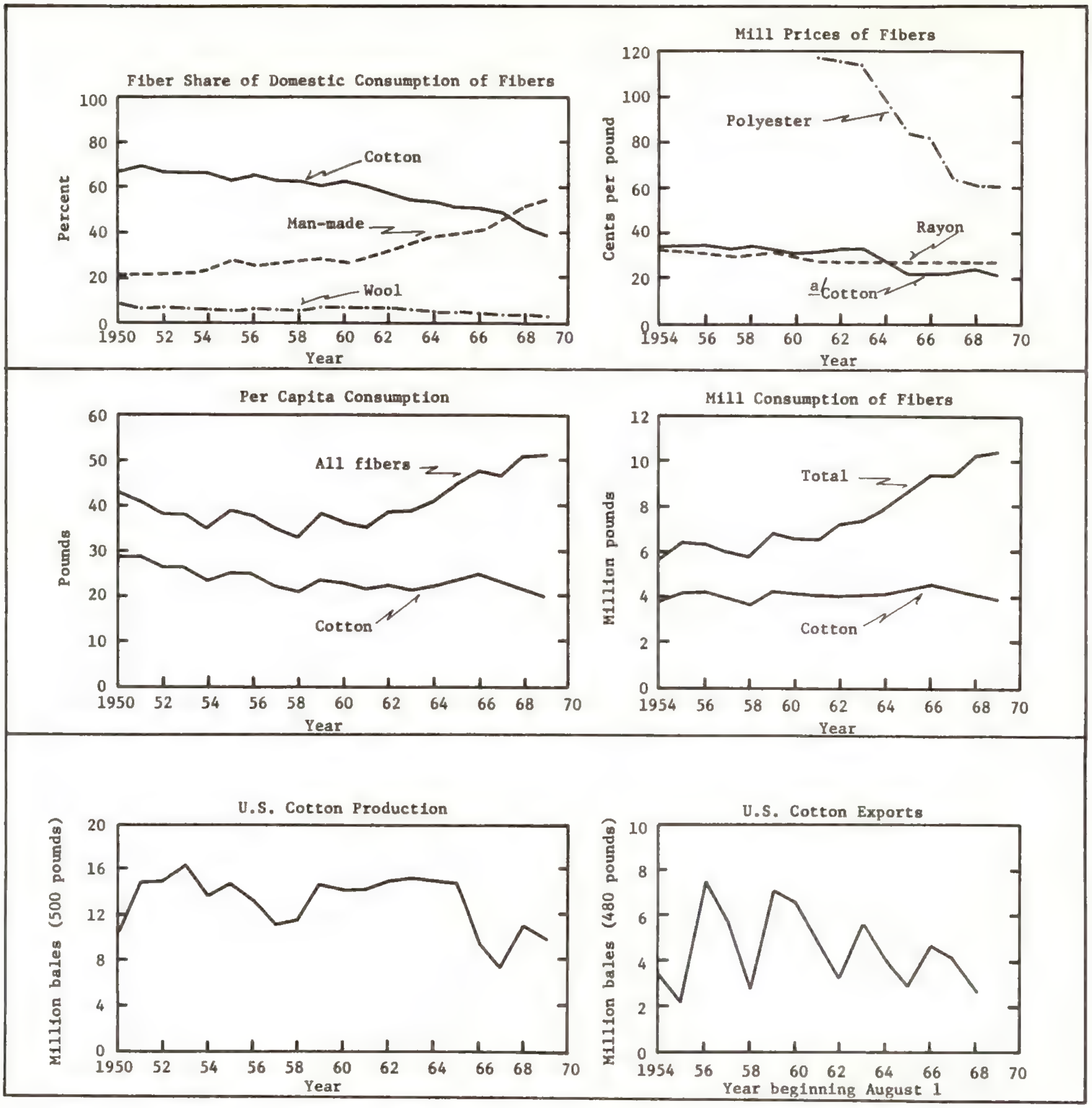


FIGURE 21. Melon Production, Farm Prices, and Per Capita Consumption, United States, 1957-69

Source: U.S. Economic Research Service [1970c].


Fiber Share of Domestic Consumption of Fibers

Mill Prices of Fibers

Per Capita Consumption

Mill Consumption of Fibers

U.S. Cotton Production

U.S. Cotton Exports

FIGURE 22. Trends Relating to the Demand for Cotton

a/ American Middling, 1 inch, average price at designated spot markets.

Source: U.S. Economic Research Service [1970a].

per capita consumption; and (5) cotton exports have varied considerably but have trended downward due to increased competition from foreign producers and competition from synthetic fibers.

Due to the above-mentioned trends, an alternative estimate of U.S. production needed to meet domestic and export markets is given in Table 26. This is 14.4 million bales (500 pounds) as compared with the Daly-Egbert estimate of 16.6 million bales. If California were to produce 13.5 percent of U.S. production (the assumption used in Table 3), the 1980 production level for California would be reduced by 10.7 percent from 2,178,000 bales to 1,944,000 bales. Given the projected increase in yield to 1980, the harvested acreage required in 1980 for the revised production lhvel would be 747,692 acres or a slight reduction from the 1961-65 average of 764,600 acres whereas the previous 1980 projection in Table 3 showed an increase to 837,692 acres.

ESTIMATED PRICE AND INCOME EFFECTS OF PROJECTED ACREAGES AND SUPPLIES

Effects on Selected Commodities

Summaries of the estimated production of specified commodities in excess of the quantities that would be demanded at constant prices were presented in Table 23. Estimates of price elasticities of demand for these same commodities were reviewed in the preceding section. Table 27 combines these data to provide estimates of the percentage reductions in price (from approximately 1961-65 average levels) which would be associated with these higher production levels. If the earlier projections and elasticities are correct, the price implications are rather serious for some crops.

Table 27 shows that deciduous fruit prices would decline about 5 to 7 percent depending on which west side production mix is considered more likely (Kip and King [1970] present more detailed alternative estimates for these fruits). Almond prices would decline from about 4 to 9 percent depending on the west side acreage allocation and the degree of substitution between walnuts and almonds. Because of a low price elasticity for grapes, the small excess supply results in price declines of from 9 to 17 percent; this may be an overestimate if the new acreage is in wine grape varieties of high demand. Orange prices show a decline of only 2 to 4 percent but this would hold only with continuation of the present allocation between fresh and processed sales.

TABLE 26

Cotton Consumption and Production Data, with Alternative Projections for 1980

Item	Units	1961-65	1966-68	1969 Preliminary	1980 Food and Fiber Commission[a]	1980 Daly-Egbert[b]	1980 Alternative estimate[c]
Per capita consumption (calendar year)							
Cotton	Pounds	22.7	23.5	20.7	22.1		20.0
Wool	Pounds	2.8	2.3	2.2	2.7		2.5
Rayon and acetate	Pounds	7.2	8.0	}28.6	7.6		}31.5
Non-cellulosics	Pounds	7.2	14.7		21.6		
TOTAL	Pounds	39.9	48.6	51.5	54.0	d/	54.0
Domestic consumption of fibers (calendar year)							
Cotton	Billion pounds	4.3	4.7	4.2	d/		4.7[e]
Wool	Billion pounds	.5	.5	.4			.4
Rayon and acetate	Billion pounds	1.4	1.6	} 5.8			} 7.6
Non-cellulosics	Billion pounds	1.4	2.9				
TOTAL	Billion pounds	7.6	9.7	10.4	13.0	d/	12.7
Mill consumption and exports (crop year)							
Mill consumption	Mil. bales (480 lbs.)	8.9	8.9	a/	11.1	10.1	9.8
Exports	Mil. bales (480 lbs.)	4.2	3.9	a/	5.2[f]	6.7[f]	4.0
TOTAL	Mil. bales (480 lbs.)	13.1	12.8	a/	16.3	16.8	13.8
Production (crop year)							
United States	Mil. bales (500 lbs.)	14.9	9.3	10.1	16.3	16.6	14.4
California	Mil. bales (500 lbs.)	1.8	1.3	1.3			

a/ National Advisory Commission on Food and Fiber [1967].

b/ Daly-Egbert [1966b].

c/ Based on lower per capita consumption of cotton in the U.S. and lower exports.

d/ Not available.

e/ Population projected at 235,000,000.

f/ Exports and stocks.

Source: U.S. Economic Research Service [1970a].

TABLE 27

Estimated Percentage Changes in Prices and Gross Returns for Selected Commodities, Based on Estimated Price Elasticities of Demand and Two Alternative Allocations of "Excess Supply"

Crop category	Estimated price elasticity of demand[a]	Percentage of "excess supply"[b]		Percentage change in price		Percentage change in gross return to industry	
		Allocation A	Allocation B	Allocation A	Allocation B	Allocation A	Allocation B
		percent					
Fruits, nuts, and grapes							
Deciduous fruits	-0.65	3.5	4.6	- 5.4	- 7.1	- 2.1	- 2.8
Almonds	-1.31	8.2 (5.0)[c]	10.7 (6.6)[c]	- 6.3 (-3.8)	- 8.2 (-5.0)	1.4 (1.0)	1.6 (1.3)
Grapes	-0.23	2.0	4.0	- 8.7	-17.4	- 6.9	-14.1
Oranges	-0.66	1.7	2.3	- 2.6[d]	- 3.5[d]	- 0.9[d]	- 1.3[d]
Vegetables							
Cantaloupes	-0.50	9.8	4.9	-19.6	- 9.8	-11.7	- 5.4
Other vegetables	-0.35	2.1	2.3	- 6.0	- 6.6	- 4.0	- 4.5
Potatoes, early spring	-0.31	26.0	13.3	-83.9	-42.9	-79.7	-35.3
Alfalfa seed	N/A	8.0	3.8	N/A	N/A	N/A	N/A

a/ Estimates based on Tables 24 and 25.

b/ From Table 23.

c/ Figure in parentheses relevant if all tree nuts considered competing market. Figure not in parentheses relevant if almonds only considered competing market.

d/ Price effect and gross returns are "minimum" reductions based on fresh market sales. As larger proportions are allocated to processing, farm prices and returns would be expected to drop substantially.

Based on industry projections, an increasing proportion of the crop will be allocated to the lower return processed markets since acreage is increasing both in Florida and in other parts of California. Thus, a much greater price decline is expected for California oranges than noted in Table 27.

Cantaloupe prices would drop from 10 to 20 percent if the projected acreages develop and the demand assumptions are valid. Other vegetable prices would drop by 6 to 7 percent. The acreage of early spring potatoes projected is so far in excess of demand that, given the low price elasticity, prices would drop precipitously. In fact, price declines of this magnitude cast serious doubt on the levels of acreage projected. No price elasticity is available for alfalfa seed. However, the projected excess production is sufficiently high to suggest sizable price reductions.

The demand elasticities used in Table 27 are at the retail level. It is generally found that demand is less elastic at the farm level. On this basis, the price effects in Table 27 are probably somewhat more pronounced at the farm level.

The last two columns of Table 27 show the projected percentage changes in gross returns for each industry, based on the other data in the table. As was pointed out previously, if the price elasticity of demand for a commodity is less than 1.0 (negative sign ignored), a given percentage increase in quantity marketed will lead to a larger percentage drop in price and gross returns to the industry will therefore decline. This is the case for most agricultural commodities, as is borne out by the data in Table 27. Only almonds show an elastic demand; however, the trend has been toward a lower elasticity over time for almonds so that, even here, the demand may be inelastic at 1980 levels of supply.

Rather substantial reductions in gross returns are shown in Table 27 for several industries.1/ Since the production costs per unit of quantity for higher levels of output are not expected to drop significantly even with higher yields per acre, the impact on net returns to growers is likely to be more severe than the gross returns figures indicate. Also, the impacts on

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1/ The drop in potato returns is not to be taken seriously as a forecast, since growers would undoubtedly react to lower prices by reduced acreages. However, it points out the inconsistency in high potato acreage projections at favorable prices used in project planning.

growers will be felt in all areas--not just the west side. Established growers producing in some cases with orchards of older rootstocks, wider tree spacing, etc., may be particularly affected by price declines.

General Comments on Projections of Price Effects

The preceding analysis is based on a number of key assumptions which are highly uncertain. One of these is the basic population projection for the United States. The population projection used in this study is based on a recent downward revision and may account in part for the apparently overoptimistic forecasts for specialty crops used in earlier studies. However, it appears that the official U.S. population projections may be lowered again in the near future.

Another critical component of the projections is the assumption that trends in acreage of specialty crops in each region of the State will continue to change at the rates of the past 15 years. One may argue that lower prices would lead to a supply response on the part of growers, resulting in lower acreages and supplies. However, the pressure for finding high income crops in all parts of the State suggests that the levels of supply projected are not unlikely. The west side acreage, particularly that part served by State water, faces extremely high water costs. Extensive production of feed grains and most other field crops under these conditions is of questionable economic feasibility. At current price-cost levels, the land is more likely to be developed for trees, grapes, and vegetables, which offer a higher payment capacity for water.

The bleak outlook for cotton suggests that producers in the already developed parts of the San Joaquin Valley and Imperial Valley will also be searching for new high income alternatives. This point is emphasized by recalling that the general projections for cotton in Part I of this report called for an increase in cotton acreage of about 75,000 acres between 1961-65 and 1980. The more detailed recent projection for cotton in Part II suggests instead a decline in cotton acreage of about 15,000 acres. The latter figure also is more in line with experience since 1961-65. Thus, it is likely that many cotton growers will be searching for high value crops to replace cotton in their cropping systems. The result of these forces could be extensive additional plantings of tree nuts, oranges, grapes, and other permanent crops as well as expansion in vegetable acreages.

Price declines of the order suggested would have several rather predictable impacts: (1) a revaluation of farmlands toward lower levels; (2) requests for additional or stronger marketing orders, quantity controls, or price and income supports; (3) requests for lower water prices; and (4) a less rapid expansion of irrigated crop land in the State.

General Comments on Land and Water Use Projections

As pointed out above, the projected rate of irrigation development in the next decade appears more than adequate to offset conversion of agricultural land to nonagricultural uses. However, many people are questioning the longer-term relationships. Food population questions are receiving considerable attention in the public press. Therefore, perhaps a relevant question to ask is: Suppose that urbanization expands at a faster rate than projected, new irrigation development increases at a slower rate than projected, current irrigated land area is reduced because of salinity and inadequate drainage, or yield increases are overestimated. The first three factors would reduce the land "available" for agricultural use in California, while the last factor would increase the acreage "required" to satisfy the projected demands for agricultural products. What would be the implications of such a development? Would it mean food shortages?

The key to these questions is in the basic assumptions of this study: the projections for California are made within the national projections of total demand and interregional competition. If the land available for agriculture in California is restricted below the levels "required" by the projections, the most likely development is that the acreage of lower valued marginal crops will move to other regions--probably the grain crops would be the dominant crops in this category. However, higher valued crops such as fruits, vegetables, nuts, and grapes--for which California has a general interregional comparative advantage--would likely remain at or near the projected levels. Livestock projections would also be little affected. Since California is already a strongly deficit area in feed grains, its feed grain prices are approximately equal to Midwest prices plus transportation costs; a larger feed grain deficit would not further raise feed grain prices to the disadvantage of livestock production.

The major point is that California is not and will not be a self-sufficient agricultural economy; nor is this a reasonable or necessary goal. California can improve its economic position by exporting those commodities in which it has a comparative advantage and importing those in which it has a comparative disadvantage. The kinds of commodities which fall in these two classes are clear from the nature of our current exports and imports in agriculture. In general, we export high value specialty crops (fruits, nuts, vegetables, etc.) and we import feed grains and meat. In case of a land "shortage," field crop production would shift elsewhere in the United States and California inshipments would increase; there are many other areas of the country with ample resources to produce such commodities. To illustrate, California currently devotes about 1.5 million of her 8.3 million irrigated acres to feed grains. Yet, California produces slightly less than 2 percent of the feed grains in the United States. Thus a shift of the large acreages of irrigated feed grains out of California could be offset by an insignificant percentage increase in the other feed grain growing regions of the United States, which currently have land held out of production by government programs.

The projections imply that a food shortage for California or the United States is not in prospect in the foreseeable future. In fact, the more immediate problem appears oversupply of particular specialty crops. Thus, there is no "shortage" of agricultural land in California for the foreseeable future as is sometimes claimed. Still a good case can be made for land use and resource planning from at least two points of view: (1) to provide an attractive and livable physical environment (e.g., provision for greenbelts and control of air and water pollution), and (2) to provide a contingency of agricultural land against extremely long-range changes in the demand for food nationally and internationally. This might be accomplished by redirection of urban growth onto land with low agricultural potential, establishment of new towns in nonagricultural areas, higher density urban development, and other measures.

SUMMARY AND CONCLUSIONS

California population and the State's industrial economy have grown tremendously since World War II. The pressures of rapid urban growth on land and water resources are of particular concern for California agriculture. Urbanization and industrialization in the Los Angeles and San Francisco Bay metropolitan centers as well as in parts of the Central Valley and Southern Coastal Valley have removed large blocks of farmland from agricultural use. A rapidly growing, affluent populace in California has also expanded the demand for recreational facilities and second home sites in the foothill and mountain regions.

Technological change in agriculture, new irrigation developments, and shifts in location of agricultural production within the State have thus far permitted California to retain its traditional share of U.S. markets for agricultural products despite the growing competition for land and water resources in the State. This study first examines possible future developments in the agricultural sector of the California economy as it attempts to adjust to resource use pressures within the State and to changes in the demands for its products; and second, examines the potential impact of the San Joaquin Valley West Side development on agriculture in California. The numerical estimates presented herein should not be regarded as unconditional forecasts of the future. Rather, they are projections of output and acreage which would be required to meet future food and fiber requirements under a specific set of assumptions which are made explicit in the study. The reasonableness of the projections will depend on the extent to which the basic assumptions are well chosen approximations of the future.

The long-range projections for California are consistent with a specific framework of assumptions regarding the U.S. economy. Important assumptions for the U.S. economy are:

(1) A U.S. population increasing to 235 million by 1980 and 308 million by 2000.

(2) An increase in real per capita income of nearly 40 percent by 1980 and over 100 percent by 2000 (compared to 1965).

Projection methods used combine arithmetic, statistical, and judgment components. California crop projections are based on (1) a previously estimated demand structure for U.S. farm products; (2) projections of California's expected share of U.S. production, by crop; (3) judgment of future yield levels by crop specialists; and (4) derivation of California's future acreages of particular crops. Projections for milk and eggs are based primarily on a projected California population of 26.5 million in 1980 and 38.6 million in 2000. Other livestock projections are based primarily on recent trends, more detailed previous studies, and judgment.

Total harvested crop acreage in California is projected to increase to about 9.0 million acres by 1980--an increase of about one-half million acres over the 1961-65 base period. About 332,000 acres of this increase is projected for the general category of fruits, nuts, and grapes, with major increases in almonds, walnuts, and oranges. Another 140,000 acres of the increase is in vegetables. Field crops are projected to increase by only about 50,000 acres by 1980. However, the acreages of particular field crops such as cotton, rice, and sugar beets could be affected considerably by changes in government programs. The total harvested crop acreage by 2000 is projected to be approximately 9.7 million acres. The additional acreage increases between 1980 and 2000 include substantial increases in all categories, although the percentage increases in the fruits, nuts, and grapes category and in vegetables are greater than for field crops. It appears likely that the projections based on U.S. markets and State market shares may overestimate the acreage of field crops in California by 2000. Cotton acreage may be overestimated because of the continued decline in U.S. and world cotton demand due to competition from synthetics; sugar acreage may be based on an overestimate of the U.S. share of the world sugar supply; and lower valued field crops such as feed grains may tend to shift to other states because of high land and water costs in California.

Dairy cattle numbers are projected to increase by 10 percent by 1980 and 38 percent by 2000 based on an expanding California market. Beef cattle feeding is projected to increase to 2.5 million head annually by 1980 and 3.2 million head by 2000 compared with about 2.1 million head annually in 1967-69. However, these projections depend on the tenuous assumption that California feedlots can remain competitive with large efficient lots now being developed in the Southern states and the Great Plains where feed grain and feeder cattle prices are lower. In the poultry industry, layers for egg production are projected to increase from about 30 million annually in 1961-65 to 36 million in 1980 and 49 million by 2000. Broiler numbers are projected to increase from 60 million annually in 1961-65 to 67.5 million in 1980 and 87.5 million in 2000. Turkey numbers are projected to increase sharply from 16 million birds annually in 1961-65 to 26.3 million in 1980 and 34.2 million in 2000.

Given these feed grain and livestock projections, it appears that California will remain a major deficit area in feed grains, with inshipments of feed grains in 1980 continuing at about the 1961-65 level of 2 million tons; inshipments are projected to increase to about 2.3 million tons by 2000.

Hay requirements can be met with little change in alfalfa acreage through 1980, although additional hay acreage appears needed by 2000.

Based on the California Water Plan, irrigated crop land acreage is projected to increase by about 0.5 million acres between 1965 and 1980 and by nearly another 1.0 million acres by 2000. This increase in net irrigated acreage would be possible despite projected losses to urbanization of about 1.0 million acres of land (not all agricultural land) between 1970 and 1980 and another 1.3 million acres between 1980 and 2000. Practically all of this increase in irrigated acreage is projected to occur in the Central Valley (the Tulare Basin, San Joaquin Basin, and the Sacramento Basin) as a result of planned irrigation development projects. The projected increase in irrigation development between 1965 and 2000 (about 1.5 million acres) appears more than adequate to meet the projected increases in harvested crop acreages over the same period (about 1.3 million acres). In fact, there is danger that the rate of irrigation development with high water costs will be too rapid to allow the added supplies of certain high value products to be absorbed at favorable market prices.

The most important new irrigation development in the State over the next decade is on the west side of the San Joaquin Valley. In this study, the region is defined as the land included in the 13 irrigation districts on the west side which now receive, or plan to receive, State or federal water from the California Aqueduct. Irrigated acreage in these districts is planned to increase from about 864,000 acres in 1968 to 1,156,000 acres in 1980 and 1,194,000 acres in 1990--increases of about 292,000 acres by 1980 and 330,000 acres by 1990. Figures on newly irrigated land alone, however, underestimate the total impact of new water supply since the new water supplements or replaces groundwater supplies in several districts. A better measure of the total increase in effective irrigated acreage is the additional land capable of receiving three acre-feet of water per year. Using this measure, the acreage capable of being intensively cropped could increase by about 426,000 acres between 1968 and 1980 and by about 454,000 acres between 1968 and 1990.

The cropping pattern which will develop on the west side is of considerable interest to growers in other parts of the State. Water costs, particularly in the areas served by State water, will be extremely high. The economic and/or financial feasibility studies prepared for the various districts show that only the higher valued crops--fruits, nuts, grapes, vegetables, and certain field crops such as cotton and alfalfa seed--have the "capacity to pay" the high water charges. Therefore, the projected crop acreages for many of the districts are dominated by such crops. Between 1968 and 1980, the District plans call for an additional 65,000 acres of fruits, nuts, and grapes; 28,000 additional acres of vegetables; 36,000 additional acres of alfalfa seed; 28,000 additional acres of sugar beets; and 51,000 additional acres of cotton. Initial plantings on the west side suggest that the feasibility studies may have overestimated the acreages of such crops as potatoes, alfalfa seed, and cantaloupes and underestimated the acreages of fruits, nuts, and grapes.

The potential price and income effects of increased plantings of these higher valued crops are estimated for 1980 conditions. A comparison of the aggregate projected State acreage of specialty crops with the projected acreages which would be "required" from California to meet demand at constant prices indicates an "excess acreage" of 107,000 acres of fruits, nuts, and grapes; 50,000 acres of vegetables; 10,000 acres of early spring potatoes; and 15,000 acres of alfalfa seed. The effect of such excess supplies on price and gross returns are evaluated by use of demand elasticities for selected commodities. Since the farm level demand for these commodities is inelastic, there are rather substantial reductions in gross returns for several commodities analyzed. The impact on growers will be felt in all producing areas, not just the west side. Established growers, producing (in some cases) with older rootstocks, wider tree spacing, etc., may be particularly affected by price declines.

APPENDIX A:

DATA ON WESTSIDE IRRIGATION DISTRICTS

TABLE A-1

Westlands Water District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)[a]	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Federal water projects[b]	1,000 Acre-feet	193	360	671	1,150	1,180	1,180	957	987	987
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1.000 Acre-feet	800	677	564	410	380	380	-390	-420	-420
Total water supply	1,000 Acre-feet	993	1,037	1,234	1,560	1,560	1,560	567	567	567
Land and soils[c]										
Irrigated acres										
Soil class A	Acres	149,000	--	--	182,000	182,000	182,000	33,000	33,000	33,000
Soil class B	Acres	171,000	--	--	208,000	208,000	208,000	37,000	37,000	37,000
Soil class C	Acres	56,000	--	--	68,000	68,000	68,000	12,000	12,000	12,000
Soil class D	Acres	51,000	--	--	63,000	63,000	63,000	12,000	12,000	12,000
Total irrigated acres	Acres	427,000	--	--	521,000	521,000	521,000	94,000	94,000	94,000
Irrigated acres capable of receiving 3 acre-feet	Acres	331,000	345,000	411,000	521,000	521,000	521,000	190,000	190,000	190,000
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	680	--	--	31,000	50,000	50,000	30,320	49,320	49,320
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	945	--	--	380	--	--	-565	-945	-945
Grapes	Acres	135	--	--	55	--	--	- 80	-135	-135
Total	Acres	1,760	--	--	31,435	50,000	50,000	29,675	48,240	48,240
Vegetables										
Potatoes	Acres	--	--	--	6,000	10,000	10,000	6,000	10,000	10,000
Melons (cantaloupes)	Acres	12,669	--	--	20,140	30,000	30,000	14,700	24,570	24,570
Other vegetables	Acres		--	--	26,860	40,000	40,000	19,631	32,761	32,761
Total	Acres	12,669	--	--	53,000	80,000	80,000	40,331	67,331	67,331
Field crops										
Alfalfa seed	Acres	33,183	--	--	67,000	90,000	90,000	33,817	56,817	56,817
Sugar beets	Acres	6,107	--	--	26,000	39,000	39,000	19,893	32,893	32,893
Cotton	Acres	130,464	--	--	143,000	152,000	152,000	12,536	21,536	21,536
Grain	Acres	153,837	--	--	240,565	169,000	169,000	-1,891	-73,456	-73,45
Safflower	Acres	76,985	--	--						
Alfalfa hay	Acres	8,461	--	--						
Miscellaneous field crops	Acres	3,173	--	--						
Total	Acres	412,210	--	--	476,565	450,000	450,000	64,355	37,790	37,790
Total harvested crop acres	Acres	426,639	--	--	561,000	580,000	580,000	134,361	153,361	153,361
Double-cropped acres	Acres	--	--	--	40,000	59,000	59,000	40,000	59,000	59,000
Net irrigated acres	Acres	426,639	--	--	521,000	521,000	521,000	94,361	94,361	94,361

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a/ Cropping system for 1965.

b/ Includes San Luis and Friant Canal water.

c/ For definitions of soil classes, see Table A-14.

Source: Westlands Water District [1968] plus interviews with District personnel (early 1970).

TABLE A-2

Empire Westside Irrigation District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	5	4	5	5	3	3	--	-2	-2
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	6	6	6	6	6	6	--	--	--
Ground water	1,000 Acre-feet	7	7	7	7	7	7	--	--	--
Total water supply	1,000 Acre-feet	18	17	18	18	16	16	--	-2	-2
Land and soils[a]										
Irrigated acres										
Soil class A	Acres	--	--	--	--	--	--	--	--	--
Soil class B	Acres	1,640	--	--	1,640	1,640	1,640	--	--	--
Soil class C	Acres	4,770	--	--	4,770	4,770	4,770	--	--	--
Soil class D	Acres	410	--	--	410	410	410	--	--	--
Total irrigated acres	Acres	6,820	--	--	6,820	6,820	6,820	--	--	--
Irrigated acres capable of receiving 3 acre-feet	Acres	6,000	5,670	6,000	6,000	5,330	5,330	--	--	--
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	--	--	--	--	--	--
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	--	--	--	--	--	--	--	--	--
Total	Acres	--	--	--	--	--	--	--	--	--
Vegetables										
Potatoes	Acres	--	--	--	--	--	--	--	--	--
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	--	--	--	--	--	--	--	--	--
Total	Acres	--	--	--	--	--	--	--	--	--
Field crops										
Alfalfa seed	Acres	530	--	--	530	530	530	--	--	--
Sugar beets	Acres	680	--	--	680	680	680	--	--	--
Cotton	Acres	2,120	--	--	2,120	2,120	2,120	--	--	--
Grain	Acres	2,470	--	--	2,470	2,470	2,470	--	--	--
Safflower	Acres	--	--	--	--	--	--	--	--	--
Alfalfa hay	Acres	--	--	--	--	--	--	--	--	--
Miscellaneous field crops	Acres	1,020	--	--	1,020	1,020	1,020	--	--	--
Total	Acres	6,820	--	--	6,820	6,820	6,820	--	--	--
Total harvested crop acres	Acres	6,820	--	--	6,820	6,820	6,820	--	--	--
Double-cropped acres	Acres	--	--	--	--	--	--	--	--	--
Net irrigated acres	Acres	6,820	--	--	6,820	6,820	6,820	--	--	--

a/ For definitions of soil classes, see Table A-14.

Source: California Department of Water Resources [1965a] plus interviews with District personnel (early 1970).

TABLE A-3

Tulare Lake Basin Water Storage District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)[a]	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	54	61	110	110	119	110	56	65	56
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	171	171	171	171	171	171	--	--	--
Ground water	1,000 Acre-feet	124	120	109	98	76	76	-26	-48	-48
Total water supply	1,000 Acre-feet	349	352	390	379	366	357	30	17	8
Land and soils[b]										
Irrigated acres										
Soil class A	Acres	--	--	--	--	--	--	--	--	--
Soil class B	Acres	14,000	--	--	15,000	15,000	15,000	1,000	1,000	1,000
Soil class C	Acres	125,000	--	--	136,000	136,000	136,000	11,000	11,000	11,000
Soil class D	Acres	14,000	--	--	15,000	15,000	15,000	1,000	1,000	1,000
Total irrigated acres	Acres	153,000	--	--	166,000	166,000	166,000	13,000	13,000	13,000
Irrigated acres capable of receiving 3 acre-feet	Acres	116,000	117,000	130,000	126,000	122,000	119,000	10,000	6,000	3,000
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	--	--	--	--	--	--
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	--	--	--	--	--	--	--	--	--
Total	Acres	--	--	--	--	--	--	--	--	--
Vegetables										
Potatoes	Acres	--	--	--	--	--	--	--	--	--
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	--	--	--	960	1,600	1,600	960	1,600	1,600
Total	Acres	--	--	--	960	1,600	1,600	960	1,600	1,600
Field crops										
Alfalfa seed	Acres	7,360	--	--	2,940	--	--	-4,420	-7,360	-7,360
Sugar beets	Acres	--	--	--	--	--	--	--	--	--
Cotton	Acres	25,760	--	--	36,580	43,800	43,800	10,820	18,040	18,040
Grain	Acres	60,720	--	--	130,820	73,100	73,100	25,940	23,620	23,620
Safflower	Acres	40,480	--	--		--	--			
Alfalfa hay	Acres	3,680	--	--		16,000	16,000			
Miscellaneous field crops	Acres	--	--	--		39,400	39,400			
Total	Acres	138,000	--	--	170,340	172,300	172,300	32,340	34,300	34,300
Total harvested crop acres	Acres	138,000	--	--	171,300	173,900	173,900	33,300	35,900	35,900
Double-cropped acres	Acres	--	--	--	5,300	7,900	7,900	5,300	7,900	7,900
Net irrigated acres	Acres	138,000	--	--	166,000	166,000	166,000	28,000	28,000	28,000

a/ Land and soils and cropping system data for 1967.

b/ For definitions of soil classes, see Table A-14.

Source: California Department of Water Resources [1965b] plus interviews with District personnel (early 1970).

TABLE A-4

Dudley Ridge Water District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)[a]	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural Water Supply										
California State Water Project	1,000 Acre-feet	26	31	58	58	58	58	32	32	32
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Total water supply	1,000 Acre-feet	26	31	58	58	58	58	32	32	32
Land and soils[b]										
Irrigated acres										
Soil class A	Acres	1,640	--	--	4,130	4,130	4,130	2,490	2,490	2,490
Soil class B	Acres	6,355	--	--	15,970	15,970	15,970	9,615	9,615	9,615
Soil class C	Acres	2,960	--	--	7,440	7,440	7,440	4,480	4,480	4,480
Soil class D	Acres	--	--	--	--	--	--	--	--	--
Total irrigated acres	Acres	10,955	--	--	27,540	27,540	27,540	16,585	16,585	16,585
Irrigated acres capable of receiving 3 acre-feet	Acres	8,670	10,330	19,330	19,330	19,330	19,330	10,660	10,660	10,660
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	850	1,400	1,400	850	1,400	1,400
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	--	--	--	420	700	700	420	700	700
Total		--	--	--	1,270	2,100	2,100	1,270	2,100	2,100
Vegetables										
Potatoes	Acres	--	--	--	600	1,000	1,000	600	1,000	1,000
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	880	--	--	1,640	2,150	2,150	760	1,270	1,270
Total		880			2,240	3,150	3,150	1,360	2,270	2,270
Field crops										
Alfalfa seed	Acres	--	--	--	2,280	3,800	3,800	2,280	3,800	3,800
Sugar beets	Acres	417	--	--	1,250	1,800	1,800	833	1,383	1,383
Cotton	Acres	6,695	--	--	7,595	8,200	8,200	900	1,505	1,505
Grain	Acres	2,573	--	--	12,755	3,600	3,600	9,792	8,277	8,277
Safflower	Acres	240	--	--		--	--			
Alfalfa hay	Acres	150	--	--		--	--			
Miscellaneous field crops	Acres	--	--	--		7,640	7,640			
Total	Acres	10,075	--	--	23,880	25,040	25,040	13,805	14,965	14,965
Total harvested crop acres	Acres	10,075	--	--	28,390	30,290	30,290	18,315	20,215	20,215
Double-cropped acres	Acres	--	--	--	2,850	4,750	4,750	2,850	4,750	4,750
Net irrigated acres	Acres	10,075	--	--	25,540	25,540	25,540	15,465	15,465	15,465

a/ Land and soils and cropping system data for 1969.

b/ For definitions of soil classes, see Table A-14.

Source: California Department of Water Resources [1964a] plus interviews with District personnel (early 1970).

TABLE A-5

Hacienda Water District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	--	--	7	10	9	9	10	9	9
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	11	11	11	11	11	11	--	--	--
Ground water	1,000 Acre-feet	1	6	6	6	6	6	5	5	5
Total water supply	1,000 Acre-feet	12	17	24	27	26	26	15	14	14
Land and soils[a/]										
Irrigated acres										
Soil class A	Acres	--	--	--	--	--	--	--	--	--
Soil class B	Acres	5,990	--	--	3,370	3,370	3,370	-2,620	-2,620	-2,620
Soil class C	Acres	2,090	--	--	1,180	1,180	1,180	- 910	- 910	- 910
Soil class D	Acres	5,840	--	--	3,300	3,300	3,300	-2,540	-2,540	-2,540
Total irrigated acres	Acres	13,920	--	--	7,850	7,850	7,850	-6,070	-6,070	-6,070
Irrigated acres capable of receiving 3 acre-feet	Acres	4,000	5,670	8,000	9,000	8,670	8,670	5,000	4,670	4,670
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	--	--	--	--	--	--
Almonds	Acres	2	--	--	--	--	--	- 2	- 2	- 2
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	42	--	--	--	--	--	-42	-42	-42
Total	Acres	44	--	--	--	--	--	-44	-44	-44
Vegetables										
Potatoes	Acres	--	--	--	--	--	--	--	--	--
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	30	--	--	--	--	--	-30	-30	-30
Total	Acres	30	--	--	--	--	--	-30	-30	-30
Field crops										
Alfalfa seed	Acres	--	--	--	360	600	600	360	600	600
Sugar beets	Acres	500	--	--	440	400	400	- 60	- 100	- 100
Cotton	Acres	1,000	--	--	1,810	2,350	2,350	810	1,350	1,350
Grain	Acres	12,350	--	--	6,020	4,200	4,200	-6,330	-6,550	-6,550
Safflower	Acres	--	--	--		--	--			
Alfalfa hay	Acres	--	--	--		--	--			
Miscellaneous field crops	Acres	--	--	--		1,600	1,600			
Total	Acres	13,850	--	--	8,630	9,150	9,150	-5,220	-4,700	-4,700
Total harvested crop acres	Acres	13,924	--	--	8,630	9,150	9,150	-5,294	-4,774	-4,774
Double-cropped acres	Acres	--	--	--	780	1,300	1,300	780	1,300	1,300
Net irrigated acres	Acres	13,924	--	--	7,850	7,850	7,850	-6,074	-6,074	-6,074

a/ For definitions of soil classes, see Table A-14.

Source: California Department of Water Resources [1964b] plus interviews with District personnel (early 1970).

TABLE A-6

Devil's Den Water District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)[a]	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural Water Supply										
California State Water Project	1,000 Acre-feet	4	5	13	13	11	11	9	7	7
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1,000 Acre-feet	4	5	6	6	6	6	2	2	2
Total water supply	1,000 Acre-feet	8	10	19	19	17	17	11	9	9
Land and soils[b]										
Irrigated acres										
Soil class A	Acres	2,760	--	--	6,150	6,150	6,150	3,390	3,390	3,390
Soil class B	Acres	--	--	--	--	--	--	--	--	--
Soil class C	Acres	120	--	--	260	260	260	140	140	140
Soil class D	Acres	20	--	--	60	60	60	40	40	40
Total irrigated acres		2,900	--	--	6,470	6,470	6,470	3,570	3,570	3,570
Irrigated acres capable of receiving 3 acre-feet	Acres	2,670	3,330	6,330	6,330	5,670	5,670	3,660	3,000	3,000
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	300	500	500	300	500	500
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	--	--	--	90	150	150	90	150	150
Total	Acres	--	--	--	390	650	650	390	650	650
Vegetables										
Potatoes	Acres	--	--	--	--	--	--	--	--	--
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	--	--	--	660	1,100	1,110	660	1,100	1,110
Total	Acres	--	--	--	660	1,100	1,110	660	1,100	1,110
Field crops										
Alfalfa seed	Acres	--	--	--	450	750	750	450	750	750
Sugar beets	Acres	--	--	--	300	500	500	300	500	500
Cotton	Acres	1,940	--	--	1,850	1,800	1,800	-90	-140	-140
Grain	Acres	960	--	--	3,150	1,200	1,200	2,190	1,710	1,710
Safflower	Acres	--	--	--		--	--			
Alfalfa hay	Acres	--	--	--		--	--			
Miscellaneous field crops	Acres	--	--	--		1,470	1,470			
Total	Acres	2,900	--	--	5,750	5,720	5,720	2,850	2,820	2,820
Total harvested crop acres	Acres	2,900	--	--	6,800	7,470	7,470	3,900	4,570	4,570
Double-cropped acres	Acres	--	--	--	1,000	1,600	1,600	1,000	1,600	1,600
Net irrigated acres	Acres	2,900	--	--	5,800	5,870	5,870	2,900	2,970	2,970

a/ Land and soils and cropping system data for 1965.

b/ For definitions of soil classes, see Table A-14.

Source: California Department of Water Resources [1965c] plus interviews with District personnel (early 1970).

TABLE A-7

Lost Hills Water District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	30	41	76	106	140	140	76	110	110
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Total water supply	1,000 Acre-feet	30	41	76	106	140	140	76	110	110
Land and soils[a]										
Irrigated acres										
Soil class A	Acres	4,800	--	--	17,000	22,000	22,000	12,200	17,200	17,200
Soil class B	Acres	1,560	--	--	5,000	7,000	7,000	3,440	5,440	5,440
Soil class C	Acres	480	--	--	2,000	2,000	2,000	1,520	1,520	1,520
Soil class D	Acres	5,160	--	--	17,000	23,000	23,000	11,840	17,840	17,840
Total irrigated acres	Acres	12,000	--	--	41,000	54,000	54,000	29,000	42,000	42,000
Irrigated acres capable of receiving 3 acre-feet	Acres	10,000	13,670	25,330	36,000	47,000	47,000	26,000	37,000	37,000
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	6,070	6,880	6,880	6,070	6,880	6,880
Almonds	Acres	4,770	--	--	--	--	--	-4,770	-4,770	-4,770
Oranges	Acres	--	--	--	740	1,232	1,232	740	1,232	1,232
Subtropical fruits	Acres	80	--	--	--	--	--	- 80	- 80	- 80
Grapes	Acres	--	--	--	2,110	3,520	3,520	2,110	3,520	3,520
Total	Acres	4,850	--	--	8,920	11,632	11,632	4,070	6,782	6,782
Vegetables										
Potatoes	Acres	--	--	--	900	1,497	1,497	900	1,497	1,497
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	370	--	--	12,290	20,234	20,234	11,920	19,864	19,864
Total	Acres	370	--	--	13,190	21,731	21,731	12,820	21,361	21,361
Field crops										
Alfalfa seed	Acres	1,560	--	--	620	--	--	-940	-1,560	-1,560
Sugar beets	Acres	560	--	--	4,330	7,771	7,771	3,770	7,211	7,211
Cotton	Acres	3,550	--	--	8,150	11,223	11,223	4,600	7,673	7,673
Grain	Acres	490	--	--	11,790	11,555	11,555	10,735	10,500	10,500
Safflower	Acres	--	--	--						
Alfalfa hay	Acres	--	--	--						
Miscellaneous field crops	Acres	565	--	--						
Total	Acres	6,725	--	--	24,890	30,549	30,549	18,165	23,824	23,824
Total harvested crop acres	Acres	11,945	--	--	47,000	63,912	63,912	35,055	51,967	51,967
Double-cropped acres	Acres	--	--	--	6,000	10,117	10,117	6,000	10,117	10,117
Net irrigated acres	Acres	11,945	--	--	41,000	53,795	53,795	29,055	41,850	41,850

[a] For definitions of soil classes, see Table A-14.

Source: Boyle Engineering [1965a] plus interviews with District personnel (early 1970).

TABLE A-8

Berrenda Mesa Water District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)[a]	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural Water Supply										
California State Water Project	1,000 Acre-feet	70	75	163	186	186	186	116	116	116
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Total water supply	1,000 Acre-feet	70	75	163	186	186	186	116	116	116
Land and soils[b]										
Irrigated acres										
Soil class A	Acres	12,000	--	--	30,000	30,000	30,000	18,000	18,000	18,000
Soil class B	Acres	5,000	--	--	13,000	13,000	13,000	8,000	8,000	8,000
Soil class C	Acres	3,000	--	--	7,000	7,000	7,000	4,000	4,000	4,000
Soil class D	Acres	--	--	--	--	--	--	--	--	--
Total irrigated acres	Acres	20,000	--	--	50,000	50,000	50,000	30,000	30,000	30,000
Irrigated acres capable of receiving 3 acre-feet	Acres	23,300	25,000	54,000	62,000	62,000	62,000	38,700	38,700	38,700
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	6,230	8,931	8,931	6,230	8,931	8,931
Almonds	Acres	2,175	--	--	--	--	--	-2,175	-2,175	-2,175
Oranges	Acres	--	--	--	6,090	10,150	10,150	6,090	10,150	10,150
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	--	--	--	4,360	7,262	7,262	4,360	7,262	7,262
Total	Acres	2,175	--	--	16,680	26,343	26,343	14,505	24,168	24,168
Vegetables										
Potatoes	Acres	--	--	--	1,690	2,819	2,819	1,690	2,819	2,819
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	10	--	--	13,900	23,104	23,104	13,890	23,094	23,094
Total	Acres	10	--	--	15,590	25,923	25,923	15,580	25,913	25,913
Field crops										
Alfalfa seed	Acres	2,720	--	--	1,088	--	--	-1,632	-2,720	-2,720
Sugar beets	Acres	1,250	--	--	1,560	1,763	1,763	310	513	513
Cotton	Acres	10,769	--	--	8,600	7,155	7,155	-2,169	-3,614	-3,614
Grain	Acres	2,730	--	--	12,482	--	--	9,612	-2,870	-2,870
Safflower	Acres	--	--	--						
Alfalfa hay	Acres	--	--	--						
Miscellaneous field crops	Acres	140	--	--						
Total	Acres	17,609	--	--	23,730	8,918	8,918	6,121	-8,691	-8,691
Total harvested crop acres	Acres	19,794	--	--	56,000	61,184	61,184	36,206	41,390	41,390
Double-cropped acres	Acres	--	--	--	6,000	11,552	11,552	6,000	11,552	11,552
Net irrigated acres	Acres	19,794	--	--	50,000	49,632	49,632	30,206	29,838	29,838

a/ Land and soils and cropping system data for 1969.

b/ For definition of soil classes, see Table A-14.

Source: Boyle Engineering [1965b] plus interviews with District personnel (1969).

TABLE A-9

Belridge Water Storage District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	25	70	88	123	163	163	98	138	138
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Total water supply	1,000 Acre-feet	25	70	88	123	163	163	98	138	138
Land and soils[a]										
Irrigated acres										
Soil class A	Acres	8,000	--	--	38,000	47,000	47,000	30,000	39,000	39,000
Soil class B	Acres	4,000	--	--	21,000	26,000	26,000	17,000	22,000	22,000
Soil class C	Acres	--	--	--	1,000	1,000	1,000	1,000	1,000	1,000
Soil class D	Acres	--	--	--	--	--	--	--	--	--
Total irrigated acres	Acres	12,000	--	--	60,000	74,000	74,000	48,000	62,000	62,000
Irrigated acres capable of receiving 3 acre-feet	Acres	8,330	23,330	29,330	41,000	54,000	54,000	32,670	45,670	45,670
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	890	1,490	1,490	890	1,490	1,490
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	--	--	--	4,040	6,730	6,730	4,040	6,730	6,730
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	--	--	--	450	750	750	450	750	750
Total	Acres	--	--	--	5,380	8,970	8,970	5,380	8,970	8,970
Vegetables										
Potatoes	Acres	160	--	--	3,210	5,240	5,240	3,050	5,080	5,080
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	150	--	--	6,110	10,080	10,080	5,960	9,930	9,930
Total	Acres	310	--	--	9,320	15,320	15,320	9,010	15,010	15,010
Field crops										
Alfalfa seed	Acres	1,200	--	--	5,850	8,950	8,950	4,650	7,750	7,750
Sugar beets	Acres	1,400	--	--	1,900	2,240	2,240	500	840	840
Cotton	Acres	--	--	--	12,550	20,910	20,910	12,550	20,910	20,910
Grain	Acres	8,320	--	--	38,000	17,190	17,190	28,680	25,420	25,420
Safflower	Acres	--	--	--		--	--			
Alfalfa hay	Acres	--	--	--		3,740	3,740			
Miscellaneous field crops	Acres	1,000	--	--		13,810	13,810			
Total	Acres	11,920	--	--	58,300	66,840	66,840	46,380	54,920	54,920
Total harvested crop acres	Acres	12,230	--	--	73,000	91,130	91,130	60,770	78,900	78,900
Double-cropped acres	Acres	--	--	--	13,000	22,390	22,390	13,000	22,390	22,390
Net irrigated acres	Acres	12,230	--	--	60,000	68,740	68,740	47,770	56,510	56,510

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[a] For definitions of soil classes, see Table A-14.

Source: California Department of Water Resources [1961] plus interviews with District personnel (early 1970).

TABLE A-10

Buttonwillow Improvement District (of Semitropic Water Storage District): Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)[a]	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	--	--	70	96	96	96	96	96	96
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1,000 Acre-feet	123	123	108	84	84	84	-39	-39	-39
Total water supply	1,000 Acre-feet	123	123	179	180	180	180	57	57	57
Land and soils[b]										
Irrigated acres										
Soil class A	Acres	7,000	--	--	8,000	9,000	9,000	1,000	2,000	2,000
Soil class B	Acres	18,000	--	--	20,000	23,000	23,000	2,000	5,000	5,000
Soil class C	Acres	16,000	--	--	19,000	22,000	22,000	3,000	6,000	6,000
Soil class D	Acres	--	--	--	--	--	--	--	--	--
Total irrigated acres	Acres	41,000	--	--	47,000	54,000	54,000	6,000	13,000	13,000
Irrigated acres capable of receiving 3 acre-feet	Acres	41,000	41,000	59,670	60,000	60,000	60,000	19,000	19,000	19,000
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	--	--	--	--	--	--
Almonds	Acres	290	--	--	370	420	420	80	130	130
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	26	--	--	34	40	40	8	14	14
Total	Acres	316	--	--	404	460	460	88	144	144
Vegetables										
Potatoes	Acres	--	--	--	--	--	--	--	--	--
Melons (cantaloupes)	Acres	479	--	--	670	800	800	191	321	321
Other vegetables	Acres	639	--	--	750	830	830	111	191	191
Total	Acres	1,118	--	--	1,420	1,630	1,630	302	512	512
Field crops										
Alfalfa seed	Acres	278	--	--	350	405	405	72	127	127
Sugar beets	Acres	2,920	--	--	3,720	4,260	4,260	800	1,340	1,340
Cotton	Acres	19,489	--	--	24,870	28,450	28,450	5,381	8,961	8,961
Grain	Acres	4,563	--	--	16,236	18,795	18,795	-779	1,780	1,780
Safflower	Acres	172	--	--						
Alfalfa hay	Acres	9,244	--	--						
Miscellaneous field crops	Acres	3,036	--	--						
Total	Acres	39,702	--	--	45,176	51,910	51,910	5,474	12,208	12,208
Total harvested crop acres	Acres	41,136	--	--	47,000	54,000	54,000	5,864	12,864	12,864
Double-cropped acres	Acres	--	--	--	--	--	--	--	--	--
Net irrigated acres	Acres	41,136	--	--	47,000	54,000	54,000	5,864	12,864	12,864

[a] Land and soils and cropping system data for 1969.

[b] For definitions of soil classes, see Table A-14.

Source: Bookman and Edmonston [1965a] plus interviews with District personnel (early 1970).

TABLE A-11

Pond-Poso Improvement District (of Semitropic Water Storage District): Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)[a]	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	--	--	58	78	78	78	78	78	78
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1,000 Acre-feet	147	147	138	95	95	95	-52	-52	-52
Total water supply	1,000 Acre-feet	147	147	196	173	173	173	26	26	26
Land and soils[b]										
Irrigated acres										
Soil class A	Acres	3,000	--	--	3,000	4,000	4,000	--	1,000	1,000
Soil class B	Acres	18,000	--	--	21,000	23,000	23,000	3,000	5,000	5,000
Soil class C	Acres	22,000	--	--	25,000	26,000	26,000	3,000	4,000	4,000
Soil class D	Acres	--	--	--	--	--	--	--	--	--
Total irrigated acres	Acres	43,000	--	--	49,000	53,000	53,000	6,000	10,000	10,000
Irrigated acres capable of receiving 3 acre-feet	Acres	49,000	49,000	65,330	57,670	57,670	57,670	8,670	8,670	8,670
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	190	--	--	220	235	235	30	45	45
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	--	--	--	--	--	--	--	--	--
Total	Acres	190	--	--	220	235	235	30	45	45
Vegetables										
Potatoes	Acres	850	--	--	970	1,050	1,050	120	200	200
Melons (cantaloupes)	Acres	--	--	--	--	--	--	--	--	--
Other vegetables	Acres	210	--	--	240	260	260	30	50	50
Total	Acres	1,060	--	--	1,210	1,310	1,310	150	250	250
Field crops										
Alfalfa seed	Acres	330	--	--	375	405	405	45	75	75
Sugar beets	Acres	3,760	--	--	4,285	4,635	4,635	525	875	875
Cotton	Acres	17,470	--	--	19,845	21,430	21,430	2,375	3,960	3,960
Grain	Acres	6,600	--	--	23,065	8,135	8,135	2,645	4,565	4,565
Safflower	Acres	--	--	--		--	--			
Alfalfa hay	Acres	13,750	--	--		16,850	16,850			
Miscellaneous field crops	Acres	70	--	--		--	--			
Total	Acres	41,980	--	--	47,570	51,455	51,455	5,590	9,475	9,475
Total harvested crop acres	Acres	43,230	--	--	49,000	53,000	53,000	5,770	9,770	9,770
Double-cropped acres	Acres	--	--	--	--	--	--	--	--	--
Net irrigated acres	Acres	43,230	--	--	49,000	53,000	53,000	5,770	9,770	9,770

a/ Land and soils and cropping system data for 1964.

b/ For definition of soil classes, see Table A-14.

Source: Bookman and Edmonston [1965b] plus interviews with District personnel (early 1970).

TABLE A-12

Buena Vista Water Storage District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)[a]	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	2	20	36	50	67	67	48	65	65
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	102[b]	102	102	109	109	109	42	42	42
Ground water	1,000 Acre-feet	70	70	63	72	75	75	2	5	5
Total water supply	1,000 Acre-feet	174	192	201	231	251	251	92	112	112
Land and soils[c]										
Irrigated acres										
Soil class A	Acres	--	--	--	--	--	--	--	--	--
Soil class B	Acres	18,000	--	--	18,000	18,000	18,000	--	--	--
Soil class C	Acres	35,000	--	--	35,000	35,000	35,000	--	--	--
Soil class D	Acres	6,000	--	--	6,000	6,000	6,000	--	--	--
Total irrigated acres	Acres	59,000	--	--	59,000	59,000	59,000	--	--	--
Irrigated acres capable of receiving 3 acre-feet	Acres	58,000	64,000	67,000	77,000	83,670	83,670	19,000	25,670	25,670
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	--	--	--	--	--	--	--	--	--
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	--	--	--	--	--	--	--	--	--
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	--	--	--	--	--	--	--	--	--
Total	Acres	--	--	--	--	--	--	--	--	--
Vegetables										
Potatoes	Acres	83	--	--	83	83	83	--	--	--
Melons (cantaloupes)	Acres	303	--	--	303	303	303	--	--	--
Other vegetables	Acres	--	--	--	--	--	--	--	--	--
Total	Acres	386	--	--	386	386	386	--	--	--
Field crops										
Alfalfa seed	Acres	137	--	--	137	137	137	--	--	--
Sugar beets	Acres	2,578	--	--	2,578	2,578	2,578	--	--	--
Cotton	Acres	30,163	--	--	30,163	30,163	30,163	--	--	--
Grain	Acres	17,857	--	--	17,857	17,857	17,857	--	--	--
Safflower	Acres	3,994	--	--	3,994	3,994	3,994	--	--	--
Alfalfa hay	Acres	4,820	--	--	4,820	4,820	4,820	--	--	--
Miscellaneous field crops	Acres	760	--	--	760	760	760	--	--	--
Total	Acres	60,309	--	--	60,309	60,309	60,309	--	--	--
Total harvested crop acres	Acres	60,695	--	--	60,695	60,695	60,695	--	--	--
Double-cropped acres	Acres	750	--	--	750	750	750	--	--	--
Net irrigated acres	Acres	59,945	--	--	59,945	59,945	59,945	--	--	--

[a] Land and soils and cropping system data for 1966.

[b] This is a "typical" supply. Actual supply was atypically low in 1968 = 67,000 acre-feet.

[c] For definitions of soil classes, see Table A-14.

Source: M & L Engineering, Inc. [1966] plus interviews with District personnel (early 1970).

TABLE A-13

Wheeler Ridge-Maricopa Water Storage District: Water Supply, Land, Soil, and Cropping Pattern--Current and Projected

Item	Unit	Current conditions (1968 unless specified otherwise)	Future conditions					Changes from current to future		
			1970	1975	1980	1990	2000	1968-80	1968-90	1968-2000
Agricultural water supply										
California State Water Project	1,000 Acre-feet	--	--	180	241	303	303	241	303	303
Federal water projects	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Other surface sources	1,000 Acre-feet	--	--	--	--	--	--	--	--	--
Ground water	1,000 Acre-feet	175	175	150	121	67	67	-54	-108	-108
Total water supply	1,000 Acre-feet	175	175	330	362	370	370	187	195	195
Land and soils[a]										
Irrigated acres										
Soil class A	Acres	51,000	--	--	95,000	95,000	95,000	44,000	44,000	44,000
Soil class B	Acres		--	--						
Soil class C	Acres	5,000	--	--	9,000	9,000	9,000	4,000	4,000	4,000
Soil class D	Acres	6,000	--	--	10,000	10,000	10,000	4,000	4,000	4,000
Total irrigated acres	Acres	62,000	--	--	114,000	114,000	114,000	52,000	52,000	52,000
Irrigated acres capable of receiving 3 acre-feet	Acres	58,330	58,330	110,000	120,670	123,330	123,330	62,340	65,000	65,000
Cropping system										
Fruits, nuts, and grapes										
Deciduous fruits	Acres	884	--	--	2,500	3,600	3,600	1,616	2,716	2,716
Almonds	Acres	--	--	--	--	--	--	--	--	--
Oranges	Acres	1,492	--	--	8,460	13,100	13,100	6,968	11,608	11,608
Subtropical fruits	Acres	--	--	--	--	--	--	--	--	--
Grapes	Acres	823	--	--	1,950	2,700	2,700	1,127	1,877	1,877
Total	Acres	3,199	--	--	12,910	19,400	19,400	9,711	16,201	16,201
Vegetables										
Potatoes	Acres	2,590	--	--	9,560	14,200	14,200	6,970	11,610	11,610
Melons (cantaloupes)	Acres	4,606	--	--	7,550	9,500	9,500	2,944	4,894	4,894
Other vegetables	Acres	4,079	--	--	21,080	30,750	30,750	17,001	26,671	26,671
Total	Acres	11,275	--	--	38,190	54,450	54,450	26,915	43,175	43,175
Field crops										
Alfalfa seed	Acres	7,213	--	--	8,280	9,000	9,000	1,067	1,787	1,787
Sugar beets	Acres	2,311	--	--	2,960	3,400	3,400	649	1,089	1,089
Cotton	Acres	26,228	--	--	29,930	32,400	32,400	3,702	6,172	6,172
Grain	Acres	9,687	--	--	31,230	11,200	11,200	19,856	-174	-174
Safflower	Acres	--	--	--		--	--			
Alfalfa hay	Acres	--	--	--		--	--			
Miscellaneous field crops	Acres	1,687	--	--		--	--			
Total	Acres	47,126	--	--	72,400	56,000	56,000	25,274	8,874	8,874
Total harvested crop acres	Acres	61,600	--	--	123,500	129,850	129,850	61,900	68,250	68,250
Double-cropped acres	Acres	4,340	--	--	9,500	15,850	15,850	5,160	11,510	11,510
Net irrigated acres	Acres	57,260	--	--	114,000	114,000	114,000	56,740	56,740	56,740

[a] For definition of soil classes, see Table A-14.

Source: Bookman and Edmonston [1967], Wheeler Ridge-Maricopa Water Storage District [1970], plus interviews with District personnel (early 1970).

TABLE A-14

Definitions of Soil Classes on the West Side

Soil class	Description of soil class
Class A	Salt: less than 2 ECe Boron: less than 0.5 ppm Texture: ranges from sandy loams to clay Permeability: moderately rapid to moderate Drainage: well drained Slope: less than 3 percent Free from "salts," exchangeable sodium, and "boron." Any of the climatically adaptable crops might be grown without a reclamation period.
Class B	Salt: 2 - 8 ECe Boron: 2 - 4 ppm Texture: ranges from loam sands to clay Permeability: moderate to rapid Drainage: well to moderately well Slope: less than 6 percent Although this soil is of good quality it is characterized by slight problems. Except for very sensitive crops all crops climatically adaptable can be grown. Yields are normally below those on class A soil. Problems might be correctable within 1 to 3 years thereby making class B soil equivalent to class A soil. Only a few very tolerant tree crops can be grown on this soil without a reclamation period.
Class C	Salt: 8 - 12 ECe Boron: 4 - 10 ppm Texture: any texture Permeability: slow to rapid Drainage: well to poorly drained Slope: less than 6 percent This soil has moderate problems (i.e., moderate salts, moderate exchangeable sodium, and moderate boron). Only tolerant crops can be grown on class C soil; yields will usually be below those obtained on A and B soils. Some of these soils can be correctable to level B, but rarely to level A. The time needed to correct these soils is usually considerable and costly.
Class D	Salt: 12 - 20 ECe Boron: greater than 10 ppm Texture: any texture Permeability: slow to rapid Drainage: moderately well to poorly drained Slope: less than 6 percent With extreme reclamation there is some possibility of growing very tolerant crops on these poor quality soils. Some of the soil is correctable to level C, and some to level B. Here again the reclamation period is both lengthy and costly.

Source: Discussions with Messrs. Eugene Begg and Gordon Huntington, soils specialists in the Department of Soils and Plant Nutrition, University of California, Davis.

APPENDIX B:

U.S. PER CAPITA CONSUMPTION OF VEGETABLES, 1943-68

TABLE B-1

Vegetables, Fresh, Canned, and Frozen: Per Capita Consumption, 1949-68

Item	Year																			
	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968[a]
	pounds (farm weight)																			
Fresh vegetables[b]																				
Tomatoes	13.5	12.9	13.3	13.1	12.8	12.9	13.4	12.3	12.6	11.9	12.8	12.6	12.6	12.7	12.0	12.1	12.1	12.4	12.4	12.0
Leafy, green and yellow																				
Artichokes	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.3	0.3	0.4	0.3
Asparagus	0.9	0.9	0.8	0.8	0.8	0.7	0.7	0.7	0.8	0.8	0.7	0.7	0.6	0.6	0.6	0.5	0.6	0.4	0.4	0.5
Lima beans (unshelled)	0.6	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2
Snap beans	4.1	3.9	3.8	3.4	3.5	3.3	3.3	2.8	2.9	2.6	2.5	2.6	2.5	2.3	2.2	2.1	2.0	1.9	2.0	1.8
Broccoli	0.9	1.0	0.7	0.8	0.7	0.6	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.3	0.4	0.3	0.3	0.3	0.3	0.4
Brussels sprouts	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	[c]	0.1	[c]
Cabbage	14.7	14.3	13.3	12.8	12.7	12.5	11.1	11.8	10.9	10.8	10.2	10.4	9.8	9.9	9.8	9.6	9.0	9.1	9.2	9.3
Carrots	8.5	8.8	8.0	7.9	7.8	7.7	7.5	7.8	7.4	7.3	7.1	7.3	6.8	7.0	7.3	6.9	7.0	6.5	6.6	7.2
Kale	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lettuce and escarole	17.8	18.6	18.6	19.8	19.6	19.6	20.6	21.6	20.8	20.1	19.9	20.0	20.3	20.5	21.3	21.0	21.6	21.5	21.8	22.2
Green peas (unshelled)	0.8	0.7	0.5	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2
Peppers	2.3	2.3	2.1	2.1	2.0	2.1	2.2	2.1	2.3	2.1	2.3	2.4	2.5	2.3	2.5	2.3	2.3	2.4	2.6	2.7
Spinach	2.0	1.7	1.6	1.5	1.4	1.1	1.0	1.1	1.0	1.1	1.0	0.9	0.8	0.7	0.7	0.6	0.7	0.6	0.6	0.5
Minor	5.6	5.3	4.4	3.9	4.4	5.1	3.6	5.0	5.5	5.4	4.6	5.9	6.2	5.3	5.1	4.8	4.6	3.9	3.6	3.9
Total	58.8	58.6	55.0	54.5	54.3	54.0	51.7	54.5	53.2	51.7	49.8	51.7	51.1	49.9	50.9	49.2	49.2	47.5	48.1	49.3
Other																				
Beets	1.2	1.1	0.9	1.0	0.9	0.8	0.8	0.8	0.8	0.7	0.7	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.4	0.4
Cauliflower[d]	3.1	3.0	2.7	2.6	2.4	1.3	1.4	1.5	1.5	1.4	1.1	1.3	1.1	1.2	1.1	1.0	1.0	1.0	0.9	1.0
Celery	8.2	8.4	8.8	8.6	8.6	8.6	8.8	8.6	8.4	7.8	7.9	8.0	7.7	7.2	6.9	6.8	6.7	6.8	6.7	7.0
Corn	7.6	7.7	7.6	7.8	7.8	8.5	8.2	7.9	7.7	8.4	8.8	8.5	8.4	8.3	8.1	7.7	8.0	7.3	7.9	7.4
Cucumbers	2.5	2.4	2.6	2.7	2.6	2.8	2.9	2.8	3.1	2.8	2.6	2.9	3.0	2.7	3.1	3.0	3.1	2.9	3.1	3.0
Eggplant	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.4	0.4	0.4	0.4
Garlic	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.3	0.3	0.4	0.3	0.2	0.3	0.4	0.4	0.3	0.4	0.5
Onions and shallots[e]	11.7	11.8	11.6	11.8	11.7	11.1	10.9	11.4	11.8	11.7	11.5	12.3	11.5	11.7	11.9	11.4	11.4	11.5	12.1	12.0
Minor	9.0	8.7	8.8	8.8	7.4	6.5	6.4	6.5	6.7	6.6	6.4	7.0	7.0	6.4	6.0	5.9	5.6	5.3	5.4	5.2
Total	43.9	43.7	43.6	44.0	42.0	40.3	40.1	40.2	40.6	40.1	39.7	41.5	40.0	38.7	38.3	37.2	37.1	35.9	37.3	36.9
Total vegetables	116.2	115.2	111.9	111.6	109.1	107.2	105.2	107.0	106.4	103.7	102.3	105.8	103.7	101.3	101.2	98.5	98.4	95.8	97.8	98.2
Melons																				
Watermelons	17.9	15.7	17.2	17.1	19.0	19.3	20.2	18.4	16.6	18.2	15.9	17.2	16.3	14.6	15.8	14.8	15.7	14.6	14.2	14.0
Cantaloupes	9.0	9.1	8.9	8.6	9.2	9.7	9.4	9.0	7.8	8.2	8.6	8.6	8.5	8.5	8.7	8.2	7.9	7.3	8.1	8.3
Total	26.9	24.8	26.1	25.7	28.2	29.0	29.6	27.4	24.4	26.4	24.5	25.8	24.8	23.1	24.5	23.0	23.6	21.9	22.3	22.3
Total fresh vegetables and melons	143.1	140.0	138.0	137.3	137.3	136.2	134.8	134.4	130.8	130.1	126.8	131.6	128.5	124.4	125.7	121.5	122.0	117.7	120.1	120.5
	pounds (processed weight)																			
Canned vegetables[f]																				
Leafy, green, and yellow																				
Asparagus	0.6	0.7	0.7	0.7	0.8	0.8	0.7	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.7	0.7	0.8	0.7	0.7	0.7
Lima beans	0.4	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.3	0.2	0.4	0.3
Snap beans	2.9	3.4	3.2	3.4	3.5	3.6	4.0	4.1	3.9	4.2	4.2	4.2	4.3	4.5	4.4	4.8	4.8	5.1	5.1	5.5
Carrots	0.3	0.4	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.6	0.5	0.6	0.6	0.6	0.6	0.7	0.7	0.6
Peas	5.3	5.4	5.4	5.1	4.9	4.9	4.8	4.9	4.8	4.7	4.9	4.4	4.4	4.1	4.1	4.1	4.1	4.2	4.1	4.2
Pumpkin and squash	0.5	0.6	0.6	0.7	0.6	0.7	0.7	0.7	0.7	0.6	0.6	0.7	0.6	0.6	0.5	0.6	0.5	0.5	0.5	0.6
Spinach	1.1	0.9	1.2	1.0	1.0	0.7	0.9	1.0	0.9	1.0	1.0	0.9	0.8	1.0	0.9	0.8	0.8	0.7	0.7	0.8
Tomato products																				
Whole tomatoes	4.7	5.1	4.9	4.1	4.5	4.6	4.5	4.6	4.6	4.6	4.6	4.6	4.8	4.6	4.6	4.4	4.4	4.5	4.6	4.6
Catsup and chili sauce	2.5	2.7	2.5	2.8	2.7	2.8	3.0	3.1	3.3	3.5	3.6	3.8	3.9	4.1	4.3	4.6	5.0	4.8	4.7	4.8
Paste and sauce	2.2	2.4	3.3	2.7	2.9	2.7	3.3	3.3	3.2	3.4	3.5	3.8	3.7[g]	3.9[g]	3.9[g]	3.9[g]	3.9[g]	4.2[g]	5.0[g]	4.7[g]
Pulp and puree	0.6	0.7	0.8	0.9	0.8	0.5	0.7	0.9	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.8	1.0	1.0	1.0
Tomato and other vegetable juices[h]	4.5	5.0	4.7	5.1	5.5	5.1	4.8	4.6	5.3	4.7	5.1	4.7	4.6	4.7	5.4	4.5	4.7	4.4	4.2	4.5
Other vegetables																				
Beets	1.0	1.2	1.5	1.4	1.4	1.4	1.3	1.5	1.4	1.4	1.4	1.3	1.3	1.4	1.5	1.4	1.4	1.4	1.4	1.3
Corn	4.9	5.2	4.9	4.8	5.2	5.2	5.3	5.3	5.4	5.4	5.1	5.3	4.9	5.5	5.6	5.6	5.5	5.2	5.4	5.7
Pickles	3.3	3.3	3.1	3.6	3.9	3.9	3.9	3.9	4.2	4.6	4.6	4.5	4.9	5.6	5.7	6.2	6.2	6.8	7.2	7.4
Sauerkraut	2.0	1.9	2.3	2.0	1.9	2.0	1.9	1.9	1.5	1.7	1.5	1.5	1.5	1.4	1.4	1.2	1.4	1.4	1.4	1.6
Sweet potatoes	0.5	0.7	0.4	0.8	0.7	0.6	0.8	0.8	0.8	1.1	1.2	0.9	1.0	1.3	1.1	1.0	1.3	1.1	1.1	1.3
Other[i]	1.7	1.9	1.8	2.0	2.1	1.5	1.9	1.6	1.7	1.7	1.5	1.7	1.8	1.5	1.5	1.5	2.1	2.1	2.2	2.2
Total canned vegetables	39.0	42.1	42.1	42.0	43.3	41.9	43.4	43.9	44.1	45.0	45.2	44.7	45.0	46.5	47.4	47.1	48.6	49.0	50.4	51.8
Frozen vegetables[j]																				
Leafy, green, and yellow																				
Asparagus	0.13	0.12	0.13	0.15	0.16	0.17	0.16	0.17	0.16	0.15	0.19	0.21	0.16	0.18	0.16	0.17	0.15	0.16	0.17	0.16
Snap beans	0.28	0.35	0.45	0.53	0.57	0.64	0.66	0.72	0.73	0.79	0.80	0.76	0.72	0.81	0.87	0.84	0.91	1.05	0.90	1.00
Lima beans	0.49	0.51	0.55	0.71	0.73	0.66	0.72	0.75	0.73	0.72	0.69	0.73	0.67	0.71	0.70	0.72	0.69	0.70	0.73	0.74
Carrots	0.10	0.08	0.09	0.11	0.13	0.17	0.21	0.15	0.26	0.26	0.27	0.35	0.33	0.39	0.34	0.42	0.51	0.55	0.65	0.72
Peas	0.75	0.86	1.02	1.16	1.25	1.40	1.34	1.50	1.58	1.64	1.61	1.75	1.64	1.83	1.78	1.81	1.98	2.05	1.87	2.07
Peas and carrots	0.04	0.06	0.08	0.10	0.09	0.11	0.10	0.08	0.12	0.11	0.14	[k]	[k]	[k]	[k]	[k]	[k]	[k]	[k]	[k]
Pumpkin and squash	0.03	0.06	0.06	0.06	0.07	0.09	0.09	0.10	0.12	0.09	0.10	0.11	0.11	0.07	0.05	0.07	0.07	0.10	0.10	0.12
Broccoli	0.21	0.22	0.31	0.44	0.43	0.47	0.54	0.54	0.50	0.56	0.59	0.63	0.59	0.62	0.59	0.66	0.68	0.71	0.77	0.78
Brussels sprouts	0.12	0.09	0.13	0.14	0.18	0.16	0.17	0.20	0.19	0.17	0.20	0.19	0.19	0.20	0.20	0.22	0.22	0.20	0.19	0.18
Spinach	0.29	0.38	0.50	0.50	0.51	0.51	0.57	0.56	0.53	0.55	0.62	0.55	0.57	0.56	0.57	0.62	0.62	0.68	0.70	0.70
Other[l]	0.11	0.15	0.22	0.33	0.30	0.36	0.54	0.39	0.51	0.64	0.67	0.84	1.03	0.97	0.80	0.88	0.88	1.07	1.07	1.24
Other vegetables																				
Cauliflower	0.10	0.09	0.13	0.18	0.16	0.17	0.19	0.19	0.15	0.17	0.20	0.19	0.19	0.22	0.19	0.20	0.20	0.25	0.25	0.26
Corn (cut basis)	0.22	0.21	0.31	0.39	0.45	0.43	0.51	0.66	0.59	0.69	0.68	0.64	0.70	0.85	0.88	0.96	1.13	1.25	1.60	1.58
Succotash	0.05	0.05	0.06	0.08	0.06	0.07	0.06	0.03	0.07	0.06	0.05	[k]	[k]	[k]	[k]	[k]	[k]	[k]	[k]	[k]
Rhubarb	0.02	0.03	0.04	0.04	0.03	0.05	0.04	0.02	0.04	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.04
Potato products	0.07	0.12	0.23	0.36	0.31	0.44	0.74	1.20	1.21	1.44	2.04	2.68	2.80	3.82	4.43	5.85	5.71	6.92	7.57	8.51
Total frozen vegetables[m]	3.01	3.38	4.31	5.28	5.43	5.90	6.64	7.26	7.49	8.07	8.88	9.66	9.74	11.26	11.59	13.45	13.78	15.72	16.60	18.10
	pounds (primary distribution weight)																			
Potatoes, sweet potatoes, dry edible beans, and dry field peas.[r]																				
Potatoes[n]	110.0	106.0	114.0	102.0	108.0	107.0	109.0	103.0	109.0	105.0	107.0	108.0	109.0	107.0	111.0	111.0	108.0	113.0	111.0	116.0
Sweet potatoes[o]	12.3	12.9	8.5	8.2	8.8	8.8	9.3	8.7	8.5	7.8	8.7	7.1	6.5	6.7	6.9	5.5	6.2	6.3	5.8	5.7
Dry edible beans[p]	6.9	8.6	8.1	8.1	7.6	8.0	7.5	8.0	7.6	7.7	7.7	7.3	7.9	7.6	7.5	7.6	6.6	6.3	6.9	6.5
Dry field peas[q]	0.4	0.8	0.7	0.5	0.6	0.6	0.5	0.7	0.6	0.4	0.8	0.6	0.3	0.8	0.7	0.6	0.6	0.2	0.1	0.1

Footnotes continued on next page.

TABLE B-1 (Footnotes continued)

a/ Preliminary.

b/ Excludes quantities produced in home gardens. Minor vegetables on basis of carlot shipment data estimated to be 43 percent "leafy, green, and yellow" in 1959, then increasing each year to 55 percent in 1955; subsequently, minor vegetables distributed each year on basis of production of known items.

c/ Less than 0.05 pound.

d/ Close trim basis since 1954; slight trim basis in prior years.

e/ Includes 0.1 pound of shallots each year through 1958; since 1958, less than 0.05 pound. In earlier years, shallots are included in minor vegetables.

f/ Excludes soups and baby food, civilian consumption.

g/ Estimated.

h/ Tomato juice comprises approximately 85 percent of the total, combination vegetable juices 13 percent, and other vegetable juices 2 percent. Combination vegetable juice contains approximately 70 percent or more tomato juice.

i/ Computed as a residual; includes miscellaneous greens, pimentos, potatoes, mixed vegetables, and all items, especially in earlier years, for which no separate data are available.

j/ Civilian consumption only.

k/ Included with "other."

l/ Included with leafy, green, and yellow because most items included are considered to be greens.

m/ Computed from unrounded data.

n/ Farm weight basis, calendar years. Includes farm garden produce not nonfarm. Includes table stock and processed potatoes.

o/ Includes canned sweet potatoes.

p/ Cleaned basis, calendar years.

q/ Cleaned basis, crop years beginning approximately September of year indicated.

Source: U.S. Department of Agriculture, Economic Research Service [1970c].

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